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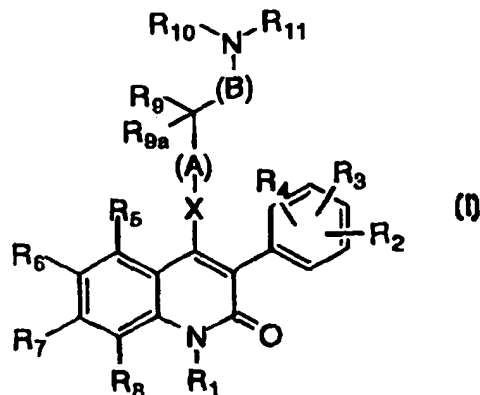
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(54) Title: ANTAGONISTS OF GONADOTROPIN RELEASING HORMONE

(57) Abstract

There are disclosed compounds of formula (I) and pharmaceutically acceptable salts thereof which are useful as antagonists of GnRH and as such may be useful for the treatment of a variety of sex-hormone related conditions in both men and women.



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TITLE OF THE INVENTION

ANTAGONISTS OF GONADOTROPIN RELEASING HORMONE

BACKGROUND OF THE INVENTION

The gonadotropin-releasing hormone (GnRH), also referred to as luteinizing hormone-releasing hormone (LHRH), is a decapeptide that plays a key role in human reproduction. The hormone is released from the hypothalamus and acts on the pituitary gland to stimulate the biosynthesis and secretion of luteinizing hormone (LH) and follicle-stimulating hormone (FSH). LH released from the pituitary gland is primarily responsible for the regulation of gonadal steroid production in both sexes, whereas FSH regulates spermatogenesis in males and follicular development in females. GnRH agonists and antagonists have proven effective in the treatment of certain conditions which require inhibition of LH/FSH release. In particular, GnRH-based therapies have proven effective in the treatment of endometriosis, uterine fibroids, polycystic ovarian disease, precocious puberty and several gonadal steroid-dependent neoplasia, most notably cancers of the prostate, breast and ovary. GnRH agonists and antagonists have also been utilized in various assisted fertilization techniques and have been investigated as a potential contraceptive in both men and women. They have also shown possible utility in the treatment of pituitary gonadotrophe adenomas, sleep disorders such as sleep apnea, irritable bowel syndrome, premenstrual syndrome, benign prostatic hyperplasia, hirsutism, as an adjunct to growth hormone therapy in growth hormone deficient children, and in murine models of lupus. The compounds of the invention may also be used in combination with bisphosphonates (bisphosphonic acids) and other agents, such as growth hormone secretagogues, e.g. MK-0677, for the treatment and the prevention of disturbances of calcium, phosphate and bone metabolism, in particular, for the prevention of bone loss during therapy with the GnRH antagonist, and in combination with estrogens, progestones, antiestrogens, antiprogestins and/or androgens for the prevention or

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treatment of bone loss or hypogonadal symptoms such as hot flashes during therapy with the GnRH antagonist.

Additionally, a compound of the present invention may be co-administered with a 5α -reductase 2 inhibitor, such as finasteride or epristeride; a 5α -reductase 1 inhibitor such as 4,7 β -dimethyl-4-aza- 5α -cholestan-3-one, 3-oxo-4-aza-4,7 β -dimethyl-16 β -(4-chlorophenoxy)- 5α -androstane, and 3-oxo-4-aza-4,7 β -dimethyl-16 β -(phenoxy)- 5α -androstane as disclosed in WO 93/23420 and WO 95/11254; dual inhibitors of 5α -reductase 1 and 5α -reductase 2 such as 3-oxo-4-aza-17 β -(2,5-trifluoromethylphenyl-carbamoyl)- 5α -androstane as disclosed in WO 95/07927; antiandrogens such as flutamide, casodex and cyproterone acetate, and alpha-1 blockers such as prazosin, terazosin, doxazosin, tamsulosin, and alfuzosin.

Further, a compound of the present invention may be used in combination with growth hormone, growth hormone releasing hormone or growth hormone secretagogues, to delay puberty in growth hormone deficient children, which will allow them to continue to gain height before fusion of the epiphyses and cessation of growth at puberty.

Current GnRH antagonists are GnRH-like decapeptides which are generally administered intravenously or subcutaneously presumably because of negligible oral activity. These have amino acid substitutions usually at positions one, two, three, six and ten.

Non-peptide GnRH antagonists offer the possible advantage of oral administration. Non-peptide GnRH antagonists have been described in European Application 0 219 292 and in De, B. et al., J. Med. Chem., 32, 2036-2038 (1989), in WO 95/28405, WO 95/29900 and EP 0679642 all to Takeda Chemical Industries, Ltd.

Arylquinolone analogs have been described in the art and include those described in the following patents, patent applications and journal articles. JP-A-63-295561 discloses a class of 3-phenyl-2(1H)-quinolone derivatives, substituted at the 4-position by an unsubstituted straight or branched alkoxy group and at the 7-position by an unsubstituted straight or branched alkoxy group. These compounds are alleged to exhibit a strong inhibitory action on bone resorption and a

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stimulatory effect on ossification, and thus to be useful as therapeutic agents for the prevention and treatment of osteoporosis.

J. Heterocycl. Chem., 1989, 26, 281 discloses a range of 3-(2-methoxyphenyl)-2(1H)-quinolones possessing a halogen substituent in the 6- or 7-position and an optional carboxylic acid substituent at the 4-position. A family of 3-phenyl-2(1H)-quinolone derivatives, substituted at the 4-position by an amino or benzylamino group and at the 7-position by a methyl or methoxy group, is described in Monatsh. Chem., 1982, 113, 751 and Vestn. Slov. Kem. Drus., 1986, 33, 271.

WO 93/10783 and WO 93/11115 disclose a class of 2-(1H)-quinolone derivatives, substituted at the 3-position by an optionally substituted aryl substituent and are selective non-competitive antagonists of NMDA receptors and/or are antagonists of AMPA receptors, and are therefore of utility in the treatment of conditions, such as neurodegenerative disorders, convulsions or schizophrenia.

FR 2711992-A1 discloses quinolone derivatives which are allegedly useful as antagonists of platelet activating factor.

SUMMARY OF THE INVENTION

The present invention relates to compounds which are non-peptide antagonists of GnRH which can be used to treat a variety of sex-hormone related conditions in men and women, to methods for their preparation, and to methods and pharmaceutical compositions containing said compounds for use in mammals.

Because of their activity as antagonists of the hormone GnRH, the compounds of the present invention are useful to treat a variety of sex-hormone related conditions in both men and women. These conditions include endometriosis, uterine fibroids, polycystic ovarian disease, hirsutism, precocious puberty, gonadal steroid-dependent neoplasias such as cancers of the prostate, breast and ovary, gonadotrophe pituitary adenomas, sleep apnea, irritable bowel syndrome, premenstrual syndrome and benign prostatic hypertrophy. They are also useful as an adjunct to treatment of growth hormone deficiency and short stature, and for the treatment of systemic lupus

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erythematosis. Further, the compounds of the invention may be useful in *in vitro* fertilization and as contraceptives. The compounds may also be useful in combination with androgens, estrogens, progesterones, antiestrogens and antiprogestogens for the treatment of endometriosis, fibroids and in contraception. They may also be useful in combination with testosterone or other androgens or antiprogestogens in men as a contraceptive. The compounds may also be used in combination with an angiotensin-converting enzyme inhibitor such as Enalapril or Captopril, an angiotensin II-receptor antagonist such as Losartan or a renin inhibitor for the treatment of uterine fibroids. Additionally, the compounds of the invention may also be used in combination with bisphosphonates (bisphosphonic acids) and other agents, for the treatment and the prevention of disturbances of calcium, phosphate and bone metabolism, in particular, for the prevention of bone loss during therapy with the GnRH antagonist, and in combination with estrogens, progesterones and/or androgens for the prevention or treatment of bone loss or hypogonadal symptoms such as hot flashes during therapy with the GnRH antagonist.

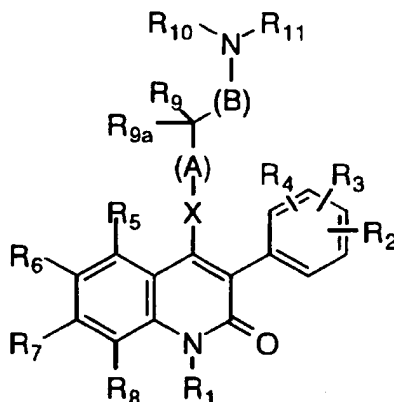
Additionally, a compound of the present invention may be co-administered with a 5α -reductase 2 inhibitor, such as finasteride or epristeride; a 5α -reductase 1 inhibitor such as 4,7 β -dimethyl-4-aza- 5α -cholestan-3-one, 3-oxo-4-aza-4,7 β -dimethyl-16 β -(4-chlorophenoxy)- 5α -androstane, and 3-oxo-4-aza-4,7 β -dimethyl-16 β -(phenoxy)- 5α -androstane as disclosed in WO 93/23420 and WO 95/11254; dual inhibitors of 5α -reductase 1 and 5α -reductase 2 such as 3-oxo-4-aza-17 β -(2,5-trifluoromethylphenyl-carbamoyl)- 5α -androstane as disclosed in WO 95/07927; antiandrogens such as flutamide, casodex and cyproterone acetate, and alpha-1 blockers such as prazosin, terazosin, doxazosin, tamsulosin, and alfuzosin.

Further, a compound of the present invention may be used in combination with growth hormone, growth hormone releasing hormone or growth hormone secretagogues, to delay puberty in growth hormone deficient children, which will allow them to continue to gain height before fusion of the epiphyses and cessation of growth at puberty.

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DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to compounds of the general formula



wherein:

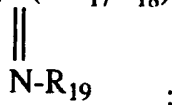
- A is a bond, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, C₁-C₆ alkoxy, substituted C₁-C₆ alkoxy;
- B is a bond, C₁-C₆ alkyl, substituted C₁-C₆ alkyl;
- X is O, S, SO, SO₂, NR₁₂, C(R₁₃R₁₄), or can be absent;
- R₁ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₃-C₆ cycloalkyl, substituted C₃-C₆ cycloalkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₂, R₃ and R₄ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, CN, nitro, C₁-C₃ perfluoroalkyl, C₁-C₃ perfluoroalkoxy, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, R₁₅O(CR₁₃R₁₄)_p-, R₁₆C(O)O(CR₁₃R₁₄)_p-, R₁₅OC(O)(CR₁₃R₁₄)_p-, -(CR₁₃R₁₄)_pS(O)_nR₁₂,

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-(CR₁₃R₁₄)_pC(O)NR₁₇R₁₈, -(CR₁₃R₁₄)_pNR₁₇C(O)R₁₆,
 -(CR₁₃R₁₄)_pN(R₁₇R₁₈) or halogen;

R₂ and R₃ taken together form a carbocyclic ring, saturated or unsaturated, of 3-7 carbon atoms or a heterocyclic ring containing 1-3 heteroatoms selected from N, O and S;

R₅, R₆, R₇ and R₈, independently are H, halogen, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, C₁-C₃ perfluoroalkyl, C₁-C₃ perfluoroalkoxy, R₁₅O(CR₁₃R₁₄)_p-, -(CR₁₃R₁₄)_pCN, -(CR₁₃R₁₄)_pSO_nR₁₂, -(CR₁₃R₁₄)_pSO₂N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)C(O)R₁₆, -(CR₁₃R₁₄)_pN(R₁₇)C(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)SO₂N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)SO₂R₁₂, -(CR₁₃R₁₄)_pC(O)OR₁₅, -(CR₁₃R₁₄)_pOC(O)R₁₆, -(CR₁₃R₁₄)_pC(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pOC(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)C(O)OR₁₅, or -(CR₁₃R₁₄)_pN(R₁₇)C(NR₁₇R₁₈)



R₉ and R_{9a} are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl; or

R₁₀ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl; or

R₁₁ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, -(CR₁₃R₁₄)_pC(O)OR₁₅; or

R₉ and R_{9a} can be taken together to form a carbocyclic ring, saturated or unsaturated, of 3-7 variously substituted carbon atoms, or;

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- R₉ and R₁₀ can be taken together to form a heterocyclic ring, saturated or unsaturated, of 4-7 atoms containing 1-3 heteroatoms selected from O, N, and S, or;
- (R₉ and R₁₀) and (R_{9a} and R₁₁) can be taken together to form a heterobicyclic ring, with each ring being independently saturated or unsaturated, of 4-7 atoms containing 1-3 heteroatoms selected from O, N, and S;
- R₁₂ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₃ and R₁₄ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₅ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₆ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₇ and R₁₈ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₃-C₆ cycloalkyl, substituted C₃-C₆ cycloalkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, or taken together form a carbocyclic ring(s) of 4-7 carbon atoms each;
- R₁₉ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl or -CN;
- n is 0, 1, or 2;
- p is 0, 1, 2, 3 or 4
- the alkyl, cycloalkyl, alkenyl and alkynyl substituents are selected from C₁-C₆ alkyl, C₃-C₇ cycloalkyl, aryl, substituted aryl, aralkyl, substituted aralkyl, hydroxy, oxo, cyano, C₁-C₆ alkoxy, fluoro, C(O)OR₁₁, aryl C₁-C₃ alkoxy, substituted aryl C₁-C₃ alkoxy, and the aryl substituents are as defined for R₃, R₄ and R₅;
- or a pharmaceutically acceptable addition salt and/or hydrate thereof, or where applicable, a geometric or optical isomer or racemic mixture thereof.

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Unless otherwise stated or indicated, the following definitions shall apply throughout the specification and claims.

When any variable (e.g., aryl, heterocycle, R₁, etc.) occurs more than one time in any constituent or in formula I, its definition on each occurrence is independent of its definition at every other occurrence. Also, combinations of substituents and/or variables are permissible only if such combinations result in stable compounds.

The term "alkyl" is intended to include both branched- and straight-chain saturated aliphatic hydrocarbon groups having the specified number of carbon atoms, e.g., methyl (Me), ethyl (Et), propyl, butyl, pentyl, hexyl, heptyl, octyl, nonanyl, decyl, undecyl, dodecyl, and the isomers thereof such as isopropyl (i-Pr), isobutyl (i-Bu), sec-butyl (s-Bu), tert-butyl (t-Bu), isopentane, isohexane, etc.

The term "aryl" includes phenyl and naphthyl. Preferably, aryl is phenyl.

The term "halogen" or "halo" is intended to include fluorine, chlorine, bromine and iodine.

The term "heterocycle" or "heterocyclic ring" is defined by all non-aromatic, heterocyclic rings of 3-7 atoms containing 1-3 heteroatoms selected from N, O, and S, such as oxirane, oxetane, tetrahydrofuran, tetrahydropyran, pyrrolidine, piperidine, tetrahydropyridine, tetrahydropyrimidine, tetrahydrothiophene, tetrahydrothiopyran, morpholine, hydantoin, valerolactam, pyrrolidinone, and the like.

In addition, it is well known to those skilled in the art that many of the foregoing heterocyclic groups can exist in more than one tautomeric form. It is intended that all such tautomers be included within the ambit of this invention.

The optical isomeric forms, that is mixtures of enantiomers, e.g., racemates, or diastereomers as well as individual enantiomers or diastereomers of the instant compound are included. These individual enantiomers are commonly designated according to the optical rotation they effect by the symbols (+) and (-), (L) and (D), (l) and (d) or combinations thereof. These isomers may also be designated

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according to their absolute spatial configuration by (S) and (R), which stands for sinister and rectus, respectively.

The individual optical isomers may be prepared using conventional resolution procedures, e.g., treatment with an appropriate optically active acid, separating the diastereomers and then recovering the desired isomer. In addition, the individual optical isomers may be prepared by asymmetric synthesis.

Additionally, a given chemical formula or name shall encompass pharmaceutically acceptable addition salts thereof and solvates thereof, such as hydrates.

The compounds of the present invention, while effective themselves, may be formulated and administered in the form of their pharmaceutically acceptable addition salts for purposes of stability, convenience of crystallization, increased solubility and other desirable properties.

The compounds of the present invention may be administered in the form of pharmaceutically acceptable salts. The term "pharmaceutically acceptable salt" is intended to include all acceptable salts. Examples of acid salts are hydrochloric, nitric, sulfuric, phosphoric, formic, acetic, trifluoroacetic, propionic, maleic, succinic, malonic, methane sulfonic and the like which can be used as a dosage form for modifying the solubility or hydrolysis characteristics or can be used in sustained release or prodrug formulations. Depending on the particular functionality of the compound of the present invention, pharmaceutically acceptable salts of the compounds of this invention include those formed from cations such as sodium, potassium, aluminum, calcium, lithium, magnesium, zinc, and from bases such as ammonia, ethylenediamine, N-methyl-glutamine, lysine, arginine, ornithine, choline, N,N'-dibenzylethylenediamine, chlorprocaine, diethanolamine, procaine, N-benzylphenethylamine, diethylamine, piperazine, tris(hydroxymethyl)aminomethane, and tetramethylammonium hydroxide. These salts may be prepared by standard procedures, e.g. by reacting a free acid with a suitable organic

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or inorganic base, or alternatively by reacting a free base with a suitable organic or inorganic acid.

Also, in the case of an acid (-COOH) or alcohol group being present, pharmaceutically acceptable esters can be employed, e.g. methyl, ethyl, butyl, acetate, maleate, pivaloyloxymethyl, and the like, and those esters known in the art for modifying solubility or hydrolysis characteristics for use as sustained release or prodrug formulations.

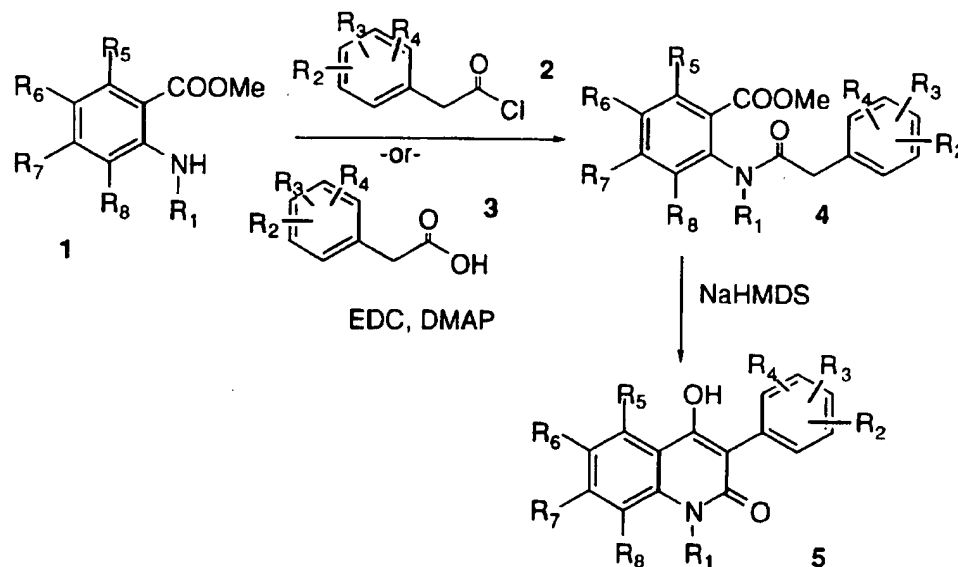
The compounds of the present invention may have chiral centers other than those centers whose stereochemistry is depicted in formula I, and therefore may occur as racemates, racemic mixtures and as individual enantiomers or diastereomers, with all such isomeric forms being included in the present invention as well as mixtures thereof. Furthermore, some of the crystalline forms for compounds of the present invention may exist as polymorphs and as such are intended to be included in the present invention. In addition, some of the compounds of the instant invention may form solvates with water or common organic solvents. Such solvates are encompassed within the scope of this invention.

As used herein, the term "composition" is intended to encompass a product comprising the specified ingredients in the specified amounts, as well as any product which results, directly or indirectly, from combination of the specified ingredients in the specified amounts.

The compounds of the invention are prepared by the following reaction schemes. All substituents are as defined above unless indicated otherwise.

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Scheme A

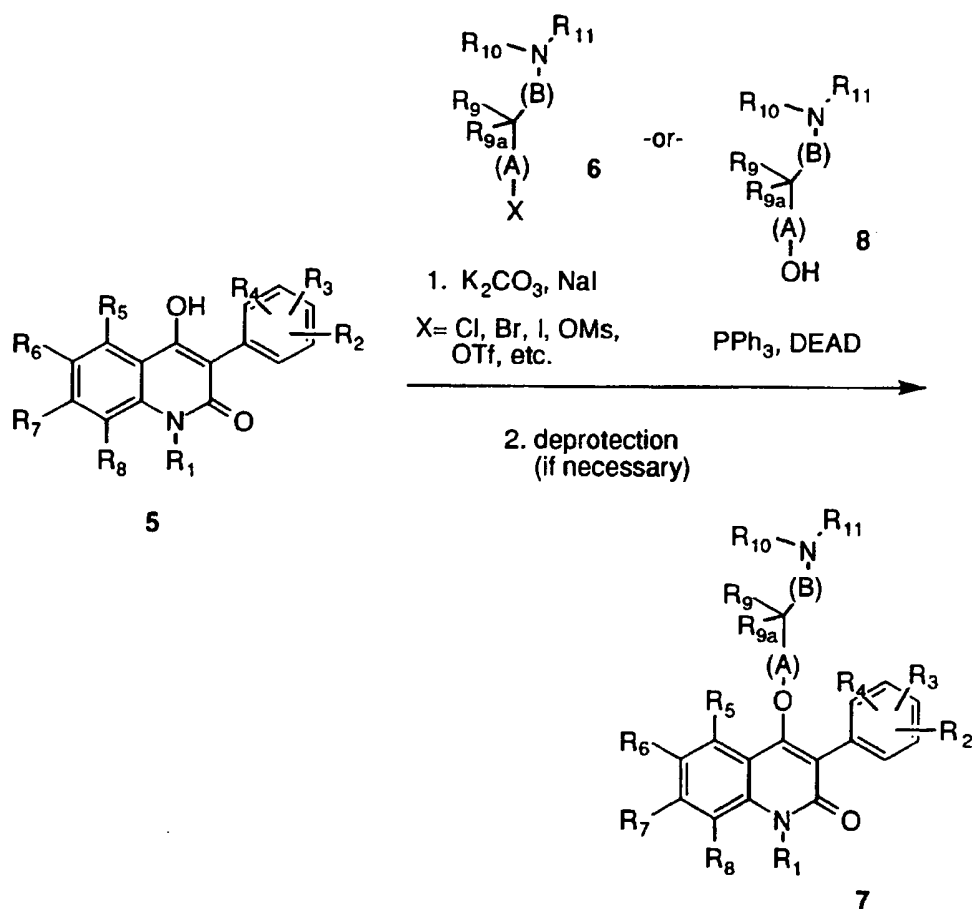
Reaction Scheme A

As shown in reaction Scheme A, treatment of amino ester (1) with an aryl acetyl chloride (2) in an inert organic solvent such as dichloroethane, chloroform, methylene chloride or the like at a temperature of 25°-80° C for a period of 30 minutes to 4 hours gives the corresponding amide (4). Alternatively, treatment of amine (1) and an arylacetic acid (3) with the coupling reagent 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC), 1,3-dicyclohexylcarbodiimide (DCC) or the like with or without 1-hydroxybenzotriazole (HOBt) and a tertiary amine base such as N-methylmorpholine (NMM), triethylamine or the like in an inert organic solvent such as methylene chloride, chloroform, dimethylformamide, or mixtures thereof at or near room temperature for a period of 3-24 hours provides the corresponding amide derivative (4). Cyclization of amide (4) is effected by treatment with a strong base such as sodium bis(trimethylsilyl)amide, lithium bis(trimethylsilyl)amide or the like in an inert organic

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solvent such as tetrahydrofuran at a temperature of -20° - 25° C for a period of 2-4 hours to give quinolone (5).

Scheme B

Reaction Scheme B

As shown in reaction Scheme B, treatment of the 4-hydroxyquinolone (5) with an alkylamine containing a halogen or sulfonate leaving group (6) and a suitable base such as potassium carbonate, sodium carbonate, sodium bicarbonate, DBU or the like along with the catalyst sodium iodide in an inert organic solvent such

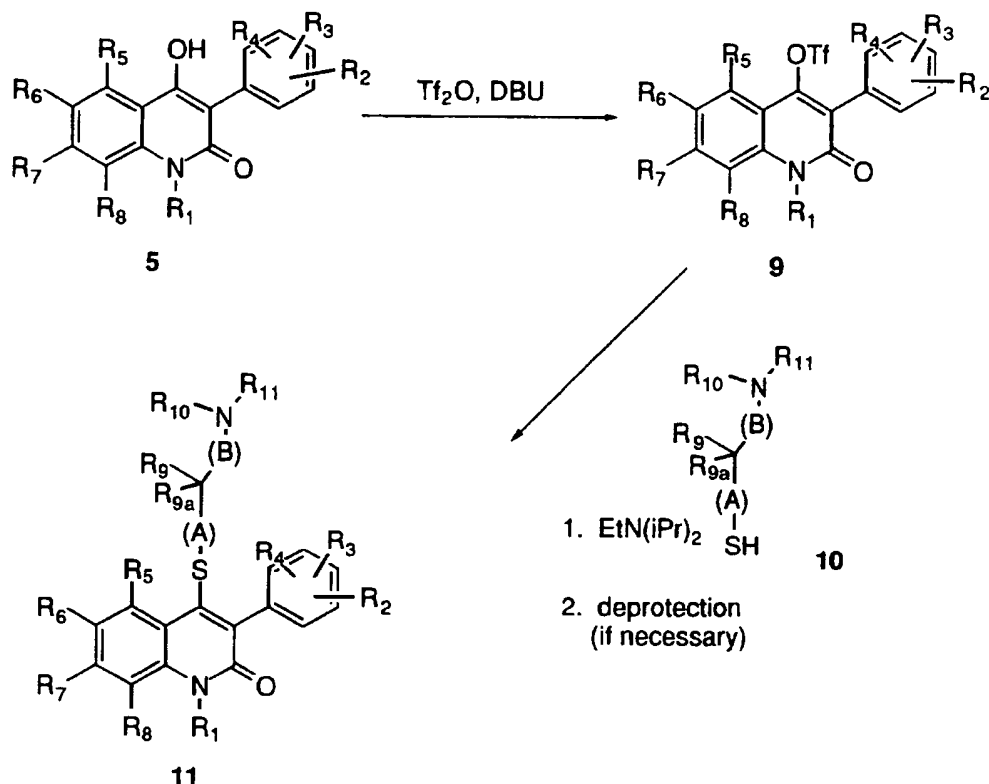
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as *N,N*-dimethylformamide, tetrahydrofuran, acetonitrile or the like at or around 80° C for a period of 4-24 hours provides the ether derivative (7). As an alternative, a suitably protected amino alcohol (8) may be coupled to (5) by treatment under Mitsunobu reaction conditions with triphenylphosphine and an activating agent such as diethyl azodicarboxylate, diisopropyl azodicarboxylate or the like in an inert solvent such as tetrahydrofuran, toluene, chlorobenzene or the like at ambient temperature for a period of 4-64 hours to give (7).

After coupling, the amino group can be deprotected by any method suitable to the protecting group used and compatible with the functionality present in (7). For example, a *t*-butyl carbamate group can be removed by treatment with a protic acid such as trifluoroacetic acid, with or without added anisole, in an inert organic solvent such as methylene chloride at ambient temperature for a period of 30 minutes to 4 hours to provide the corresponding amine.

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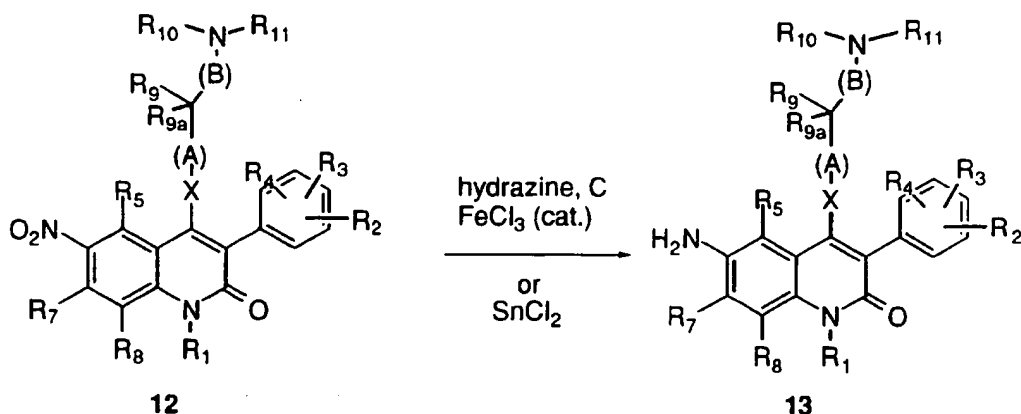
Scheme C

Reaction Scheme C

As shown in reaction Scheme C, the 4-hydroxyquinolone structure (5) may be modified by conversion to a sulfonate leaving group such as the trifluoromethanesulfonate (9) upon treatment with trifluoromethane-sulfonic anhydride in an inert organic solvent such as methylene chloride and an amine base such as diazabicycloundecene, 2,6-lutidine, pyridine or the like at or below room temperature for a period of 30 minutes to 2 hours. Reaction of (9) with an appropriate thiol (10) and an amine base such as diisopropylethylamine, triethylamine or the like in an inert organic solvent such as *N,N*-dimethylformamide at or below room temperature for a period of 4-24 hours gives the thioether analog (11).

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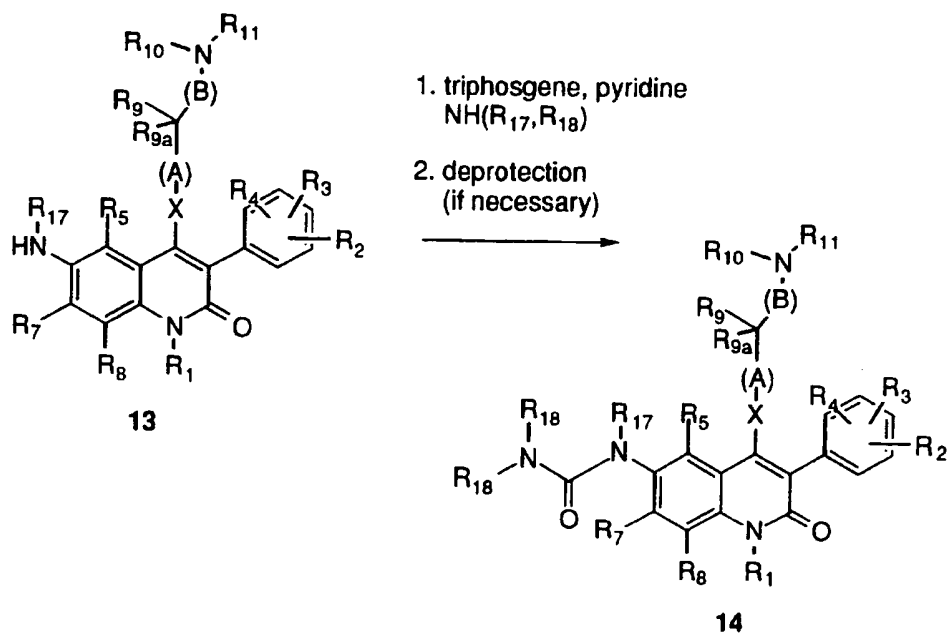
Scheme D

Reaction Scheme D

As shown in reaction Scheme D, nitro groups appended to these structures, such as in (12), can be reduced to the corresponding amines (13) by treatment with hydrazine and a reduction catalyst such as iron (III) chloride and carbon in an inert organic solvent such as methanol, ethanol or the like at a temperature of 65°-100° C for a period of 5-20 hours. Alternatively, treatment of (12) with tin(II)chloride dihydrate in a polar solvent such as ethanol or methanol at a temperature of 70°-80° C for a period of 30 minutes to 4 hours gives the reduced, amino derivative (13).

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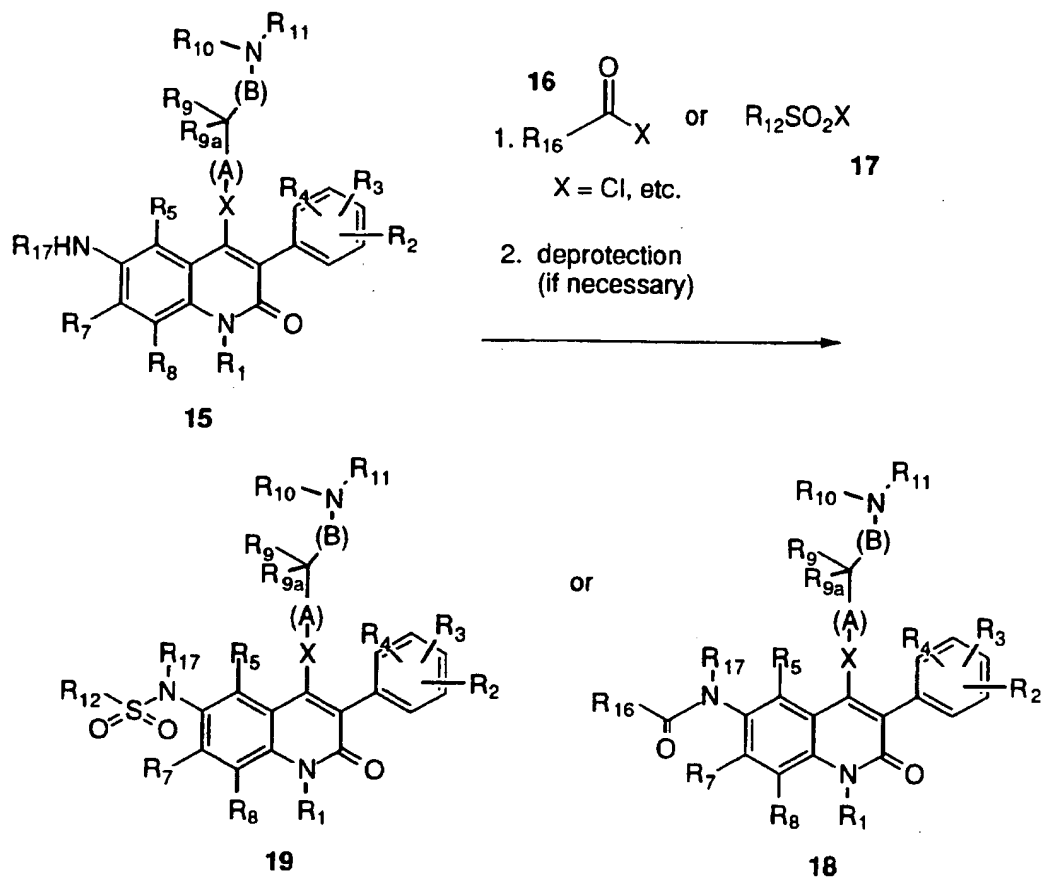
Scheme E

Reaction Scheme E

As shown in reaction Scheme E, amines such as (13) can be converted to the corresponding urea derivatives (14) by treatment with an appropriate acylating agent such as phosgene, triphosgene, carbonyldiimidazole or the like, with or without an amine base such as pyridine in an inert organic solvent such as methylene chloride, chloroform, dichloroethane or the like together with the desired primary or secondary amine at 0°-25°C for a period of 1-48 hours.

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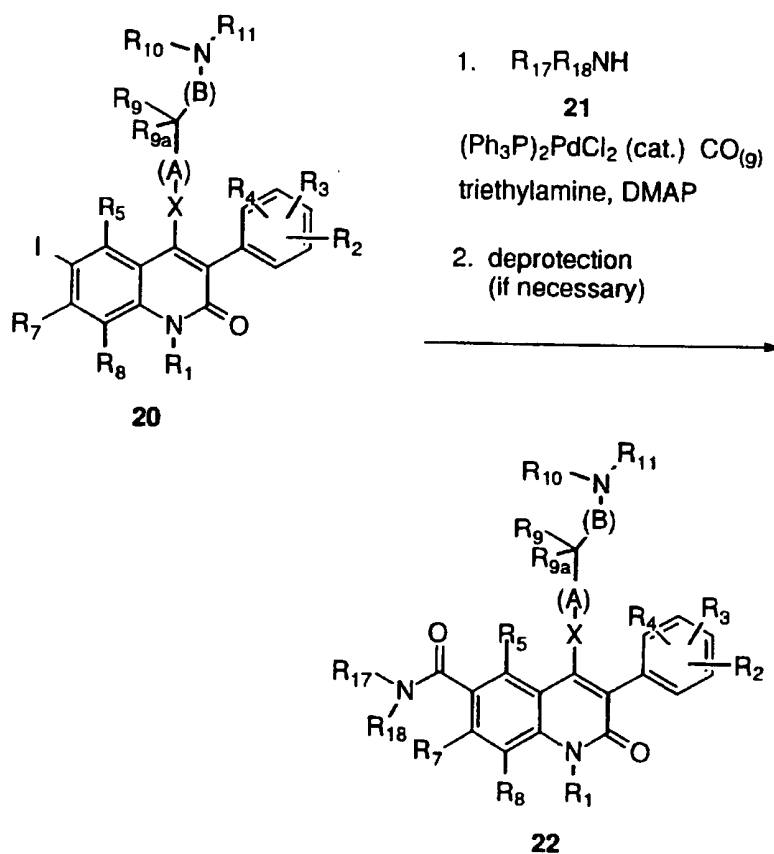
Scheme F

Reaction Scheme F

As shown in reaction Scheme F, amines such as (15) can be converted to the corresponding amide (18) or sulfonamide derivatives (19) by treatment with an appropriate acylating agent such as an acetyl chloride, acid anhydride, sulfonylchloride, sulfonic anhydride or the like, with or without an amine base such as pyridine, in an inert organic solvent such as methylene chloride, chloroform, dichloroethane, benzene, toluene, chlorobenzene or the like at 0°-100°C for a period of 1-10 hours.

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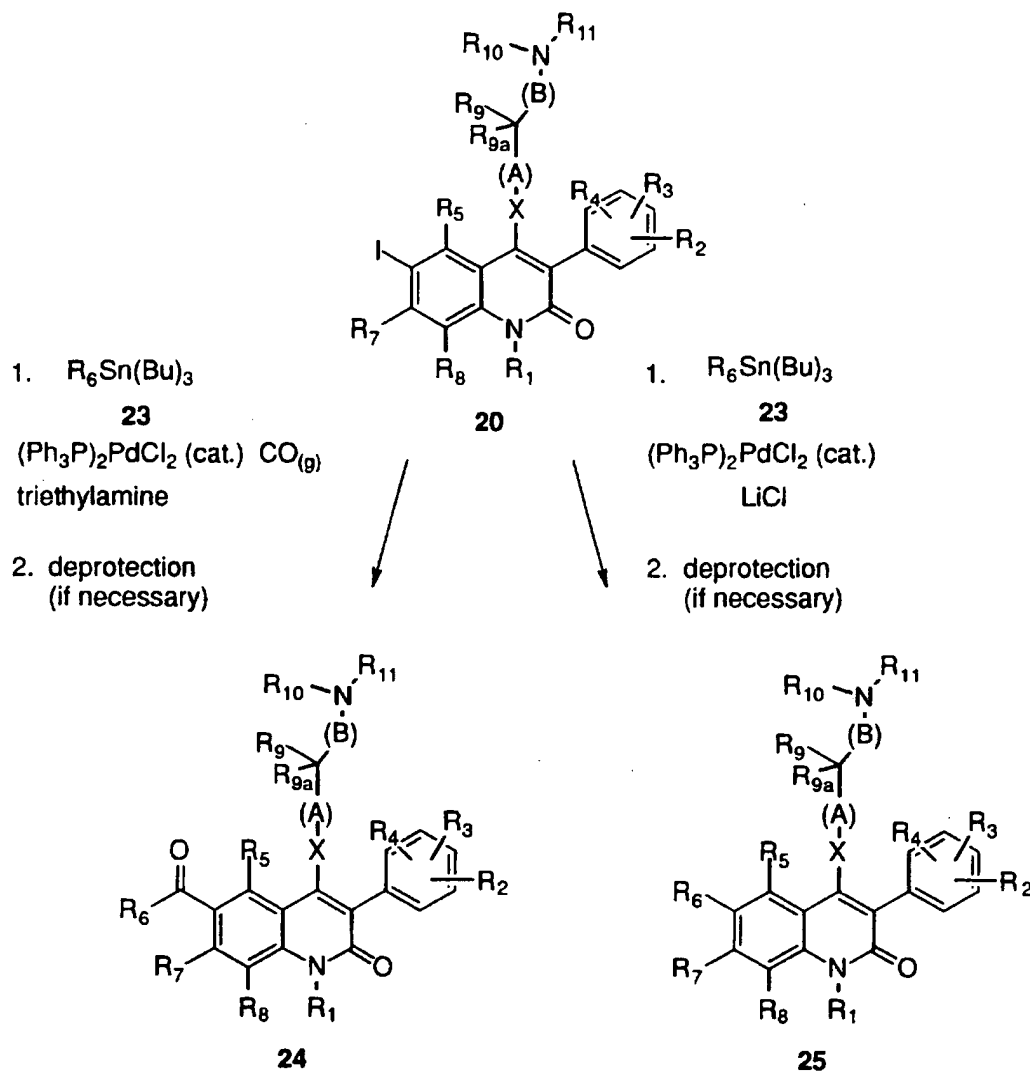
Scheme G

Reaction Scheme G

As shown in Scheme G, iodides such as (20) can be converted to the corresponding amide (22) by treatment with an appropriate amine (21) and a palladium catalyst such as dichlorobis(triphenylphosphine)palladium(II) in the presence of an amine base such as triethylamine in an inert organic solvent such as *N,N*-dimethylformamide, or the like, under an atmosphere of carbon monoxide at 90 °C for a period of 5-25 hours.

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Scheme H

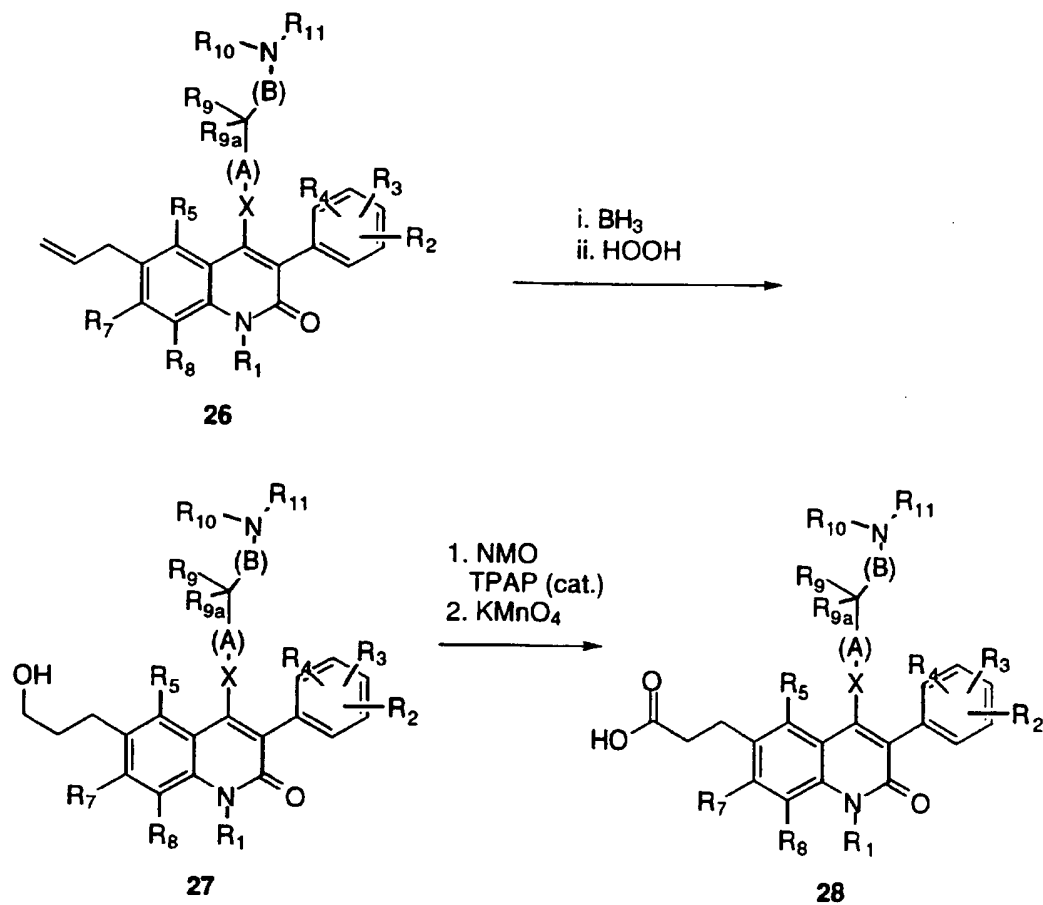


ReReaction Scheme H

As shown in Reaction Scheme H, iodide (20) can be coupled with alkyl-, vinyl-, aryl- and heteroaryl-stannanes (23) using an appropriate palladium catalyst such as dichlorobis(triphenylphosphine) palladium(II) in an inert organic solvent such as N,N-dimethyl formamide, toluene, or the like, at a temperature of 80-110 °C with or without the presence of carbon monoxide to provide ketones (24) and carbon-linked derivatives (25), respectively.

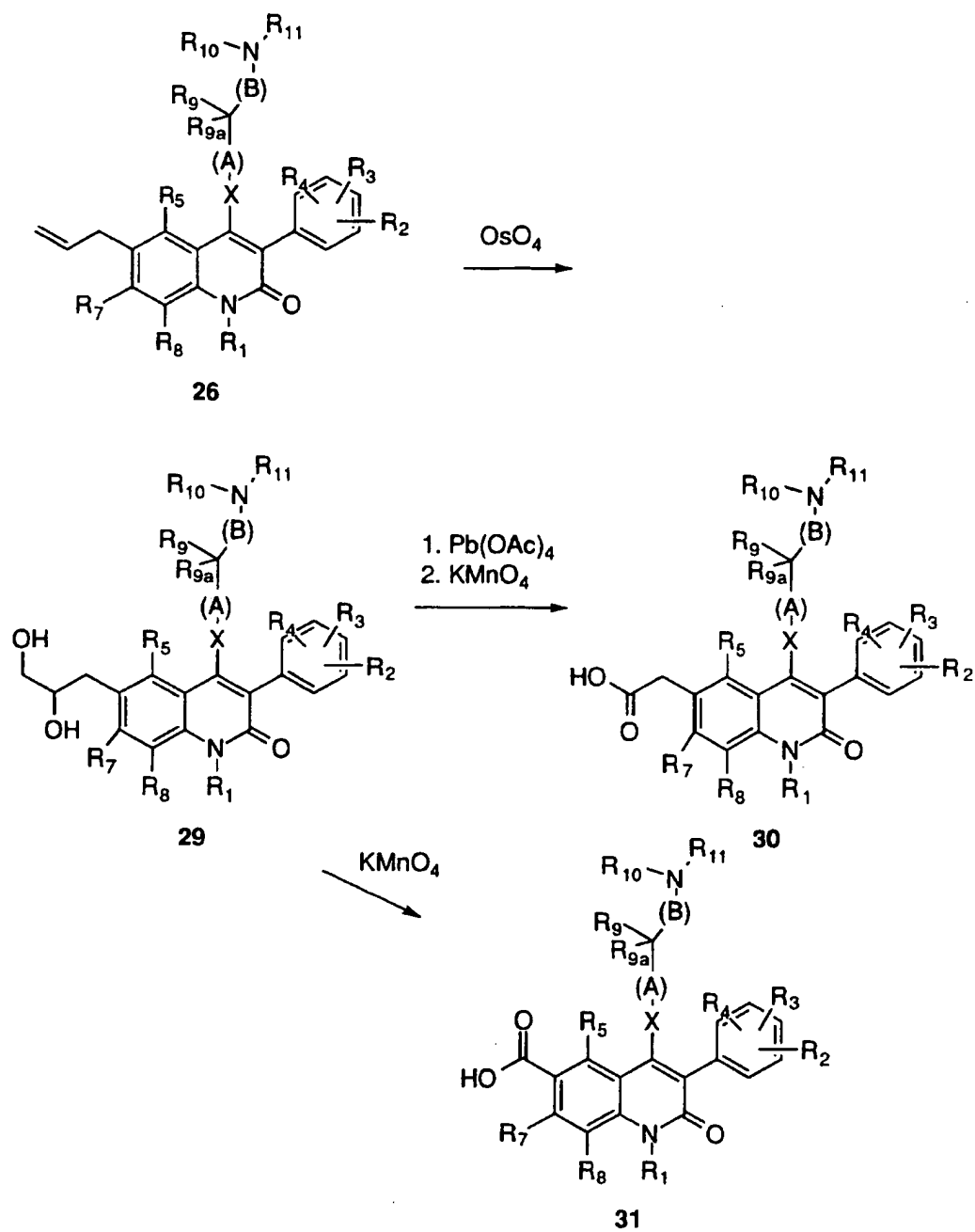
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Scheme I

Reaction Scheme I

As shown in Scheme I, the allyl derivative (26) can be converted to primary alcohol (27) by treatment with borane or a suitable alkylborane reagent in an inert solvent such as tetrahydrofuran followed by exposure to a mild oxidant such as hydrogen peroxide. Alcohols such as (27) can be further oxidized by treatment with tetrapropylammonium perruthenate(VII) and 4-methylmorpholine-*N*-oxide or similarly mild oxidants in an organic solvent such as methylene chloride at room temperature for a period of 1 to 5 hours to give the corresponding aldehyde. Further oxidation to the carboxylic acid can be conducted with a strong oxidant such as potassium permanganate to give acids such as (28).

Scheme J



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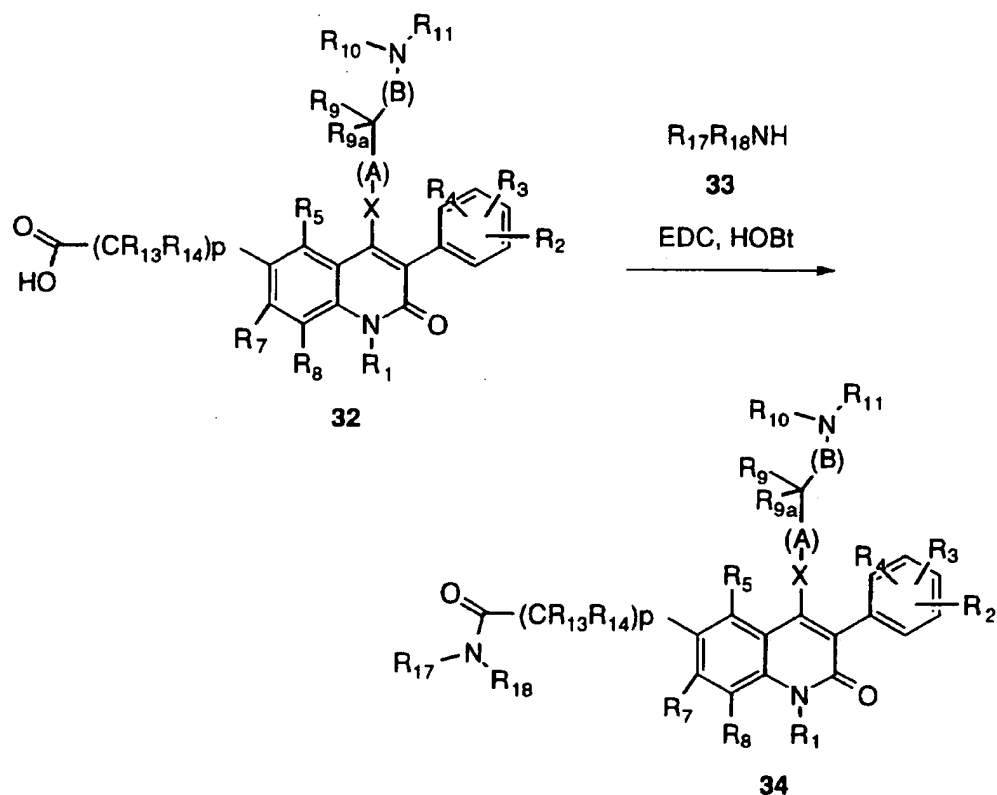
Reaction Scheme J

As shown in Scheme J, the allyl derivative (26) can be converted to the diol (29) by treatment with osmium tetroxide with or without a co-oxidant such as 4-methylmorpholine-*N*-oxide in an inert solvent such as tetrahydrofuran, tert-butanol, water or mixtures thereof at room temperature for a period of 15 minutes to 5 hours. Diols such as (29) can be further oxidized by treatment with lead (IV) acetate in an inert solvent such as methanol pyridine or mixtures thereof at room temperature for a period of 10 minutes to 2 hours to give the corresponding aldehyde derivative. Further oxidation to the carboxylic acid can be conducted with a strong oxidant such as potassium permanganate to give acids such as (30).

Alternatively, treatment of diol (29) with a strong oxidant such as potassium permanganate, ruthenium tetroxide or the like can give the benzoic acid product (31) directly.

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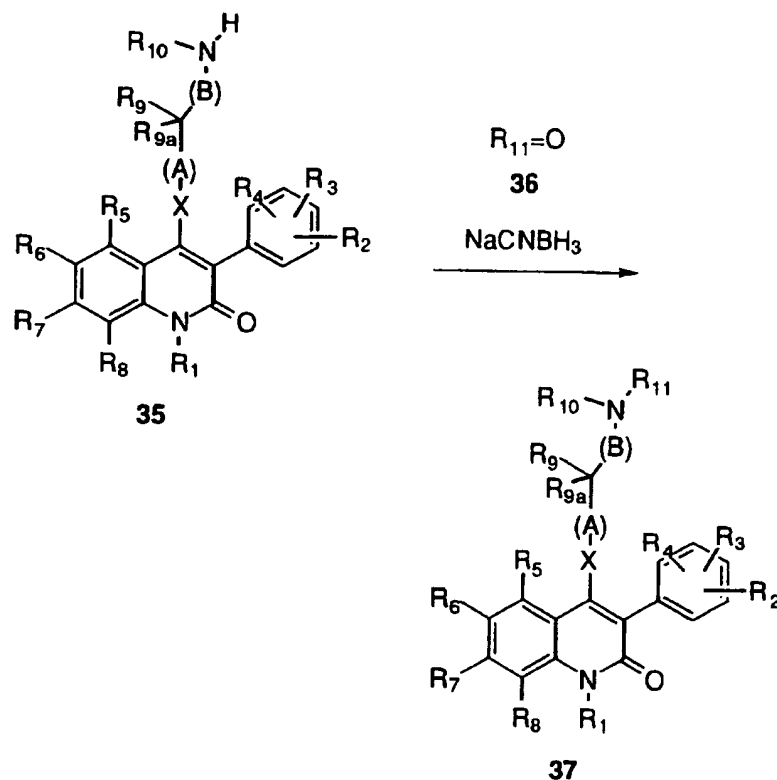
Scheme K

Reaction Scheme K

As shown in Scheme K, treatment of carboxylic acid (**32**) and an appropriate amine such as (**33**) with the coupling reagent 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC), 1,3-dicyclohexylcarbodiimide (DCC) or the like with or without 1-hydroxybenzotriazole (HOBt) and a tertiary amine base such as N-methylmorpholine (NMM), triethylamine or the like in an inert organic solvent such as methylene chloride, chloroform, dimethylformamide, or mixtures thereof at or near room temperature for a period of 3-24 hours provides the corresponding amide derivative (**34**).

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Scheme L

**Reaction Scheme L**

As shown in Scheme L, amines such as (35) can undergo reductive amination with carbonyl -containing compounds like (36) by treating the pair with a dessicant such as molecular sieves or magnesium sulfate and an acid catalyst such as acetic acid in an inert organic solvent such as methanol, chloroform or the like followed by a reducing agent such as sodium cyanoborohydride, sodium borohydride, or hydrogen and an appropriate metal catalyst to give derivative (37).

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The compounds of the present invention are useful in the treatment of various sex-hormone related conditions in men and women. This utility is manifested in their ability to act as antagonists of the neuropeptide hormone GnRH as demonstrated by activity in the following *in vitro* assays.

Human GnRH receptor binding assay

Crude membranes prepared from CHO cells expressing human GnRH receptors were the sources for GnRH receptor. [¹²⁵I]Buserelin (a peptidyl GnRH analog) was used as the radiolabelled ligand. The binding activity was determined as an IC₅₀ which is the antagonist concentration required to inhibit the specific binding of [¹²⁵I]buserelin to GnRH receptors by 50%.

Rat pituitary GnRH receptor binding assay:

Crude plasma membranes prepared from rat pituitary tissues were incubated in a Tris.HCl buffer (50 mM, pH. 7.5) containing bovine serum albumin (.1%), [1-125]D-t-Bu-Ser6-Pro9-ethyl amide-GnRH, and the desired concentration of a test compound. The assay mixtures were incubated at 4°C for 90-120 minutes followed by rapid filtration and repeated washings through a glass fiber filter. The radioactivity of membrane bound radioligands was determined in a gamma-counter. From this data, the IC₅₀ of the radioligand binding to GnRH receptors in the presence of test compound was estimated.

Inhibition of LH release assay:

Active compounds from the GnRH receptor binding assay were further evaluated with an *in vitro* LH release assay to confirm their antagonist activity (blocking GnRH-induced LH release).

1. Sample Preparation

The compounds to be assayed were dissolved and diluted in DMSO. The final concentration of DMSO in the incubation medium was 0.5%.

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2. Assay

The Wistar male rats (150-200 grams) were obtained from Charles River Laboratories (Wilmington, MA). Rats were maintained at a constant temperature (25°C) on a 12-hr light, 12-hr dark cycle. Rat chow and water were available *ad libitum*. The animals were sacrificed by decapitation and pituitary glands were aseptically removed and placed in Hank's Balanced Salt Solution (HBSS) in a 50-ml polypropylene centrifuge tube. The collection tube was centrifuged for 5 min at 250 x g, and HBSS was removed by aspiration. Pituitary glands were transferred to a disposable petri plate and minced with a scalpel. The minced tissue was then transferred to a 50-ml disposable centrifuge tube by suspending the tissue fragments in three successive 10-mL aliquots of HBSS containing 0.2% collagenase and 0.2% hyaluronidase. The cell dispersion was carried out in a water bath at 37°C with gentle stirring for 30 min. At the end of the incubation, the cells were aspirated 20 to 30 times with a pipet and the undigested pituitary fragments were allowed to settle for 3 to 5 min. The suspended cells were removed by aspiration, and then subjected to a 1200 x g centrifugation for 5 min. The cells were then resuspended in Culture medium. The undigested pituitary fragments were treated with 30 mL aliquots of the digestion enzymes as above for a total of 3 digestions with the collagenase/hyaluronidase mixture. The resulting cell suspensions were pooled, counted and diluted to a concentration of 3×10^5 cells/mL, and 1.0 mL of this suspension was placed in each well of a 24-well tray (Costar, Cambridge, MA). Cells were maintained in a humidified 5% CO₂-95% air atmosphere at 37°C for 3 to 4 days. The culture medium consisted of DMEM containing 0.37% NaHCO₃, 10% horse serum, 2.5% fetal bovine serum, 1% non-essential amino acids, 1% glutamine, and 0.1% gentamycin. On the day of an experiment, cells were washed three times 1 1/2 hrs prior to and two more times immediately before the start of the experiment with DMEM containing 0.37% NaHCO₃, 10% horse serum, 2.5% fetal bovine serum, 1% non-essential amino acids(100X), 1% glutamine(100X), 1% Penicillin/Streptomycin(10,000 Units of Penicillin and 10,000

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micrograms of Streptomycin per ml), and 25 mM HEPES, pH 7.4. LH release was initiated by adding 1 ml of fresh medium containing test compounds in the presence of 2 nM GnRH to each well in duplicate. Incubation was carried out at 37°C for 3 hr. After incubation, medium was removed and centrifuged at 2,000 x g for 15 min to remove any cellular material. The supernatant fluid was removed and assayed for LH content with a double antibody RIA procedure using materials obtained from Dr. A. F. Parlow (Harbor-UCLA Medical Center, Torrance, CA).

The compounds of formula I are useful in a number of areas affected by GnRH. They may be useful in sex-hormone related conditions, sex-hormone dependent cancers, benign prostatic hypertrophy or myoma of the uterus. Sex-hormone dependent cancers which may benefit from the administration of the compounds of this invention include prostatic cancer, uterine cancer, breast cancer and pituitary gonadotrophe adenomas. Other sex-hormone dependent conditions which may benefit from the administration of the compounds of this invention include endometriosis, polycystic ovarian disease, uterine fibroids and precocious puberty. The compounds may also be used in combination with an angiotensin-converting enzyme inhibitor such as Enalapril or Captopril, an angiotensin II-receptor antagonist such as Losartan or a renin inhibitor for the treatment of uterine fibroids.

The compounds of the invention may also be useful for controlling pregnancy, as a contraceptive in both men and women, for *in vitro* fertilization, in the treatment of premenstrual syndrome, in the treatment of lupus erythematosus, in the treatment of hirsutism, in the treatment of irritable bowel syndrome and for the treatment of sleep disorders such as sleep apnea.

A further use of the compounds of this invention is as an adjunct to growth hormone therapy in growth hormone deficient children. The compounds may be administered with growth hormone or a compound which increases the endogenous production or release of growth hormone. Certain compounds have been developed which

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stimulate the release of endogenous growth hormone. Peptides which are known to stimulate the release of endogenous growth hormone include growth hormone releasing hormone, the growth hormone releasing peptides GHRP-6 and GHRP-1 (described in U.S. Patent No. 4,411,890, PCT Patent Pub. No. WO 89/07110, and PCT Patent Pub. No. WO 89/07111) and GHRP-2 (described in PCT Patent Pub. No. WO 93/04081), as well as hexarelin (J. Endocrinol Invest., 15(Suppl 4), 45 (1992)). Other compounds which stimulate the release of endogenous growth hormone are disclosed, for example, in the following: U.S. Patent No. 3,239,345; U.S. Patent No. 4,036,979; U.S. Patent No. 4,411,890; U.S. Patent No. 5,206,235; U.S. Patent No. 5,283,241; U.S. Patent No. 5,284,841; U.S. Patent No. 5,310,737; U.S. Patent No. 5,317,017; U.S. Patent No. 5,374,721; U.S. Patent No. 5,430,144; U.S. Patent No. 5,434,261; U.S. Patent No. 5,438,136; EPO Patent Pub. No. 0,144,230; EPO Patent Pub. No. 0,513,974; PCT Patent Pub. No. WO 94/07486; PCT Patent Pub. No. WO 94/08583; PCT Patent Pub. No. WO 94/11012; PCT Patent Pub. No. WO 94/13696; PCT Patent Pub. No. WO 94/19367; PCT Patent Pub. No. WO 95/03289; PCT Patent Pub. No. WO 95/03290; PCT Patent Pub. No. WO 95/09633; PCT Patent Pub. No. WO 95/11029; PCT Patent Pub. No. WO 95/12598; PCT Patent Pub. No. WO 95/13069; PCT Patent Pub. No. WO 95/14666; PCT Patent Pub. No. WO 95/16675; PCT Patent Pub. No. WO 95/16692; PCT Patent Pub. No. WO 95/17422; PCT Patent Pub. No. WO 95/17423; Science, 260, 1640-1643 (June 11, 1993); Ann. Rep. Med. Chem., 28, 177-186 (1993); Bioorg. Med. Chem. Ltrs., 4(22), 2709-2714 (1994); and Proc. Natl. Acad. Sci. USA 92, 7001-7005 (July 1995).

Representative preferred growth hormone secretagogues employed in the present combination include the following:

1) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;

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- 2) N-[1(R)-[(1,2-Dihydro-1-methanecarbonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;
- 3) N-[1(R)-[(1,2-Dihydro-1-benzenesulfonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;
- 4) N-[1(R)-[(3,4-Dihydro-spro[2H-1-benzopyran-2,4'-piperidin]-1'-yl)carbonyl]-2-(1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;
- 5) N-[1(R)-[(2-Acetyl-1,2,3,4-tetrahydro-spro[isoquinolin-4,4'-piperidin]-1'-yl)carbonyl]-2-(indol-3-yl)ethyl]-2-amino-2-methylpropanamide;
- 6) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(phenylmethyloxy)ethyl]-2-amino-2-methylpropanamide;
- 7) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(phenylmethyloxy)ethyl]-2-amino-2-methylpropanamide methanesulfonate;
- 8) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(2',6'-difluorophenylmethyloxy)ethyl]-2-amino-2-methylpropanamide;
- 9) N-[1(R)-[(1,2-Dihydro-1-methanesulfonyl-5-fluoro-spro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(phenylmethyloxy)ethyl]-2-amino-2-methylpropanamide;
- 10) N-[1(S)-[(1,2-Dihydro-1-methanesulfonylspro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(phenylmethylthio)ethyl]-2-amino-2-methylpropanamide;

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11) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-3-phenylpropyl]-2-amino-2-methylpropanamide;

12) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-3-cyclohexylpropyl]-2-amino-2-methylpropanamide;

13) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-4-phenylbutyl]-2-amino-2-methylpropanamide;

14) N-[1(R)-[(1,2-Dihydro-1-methanesulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(5-fluoro-1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;

15) N-[1(R)-[(1,2-Dihydro-1-methanesulfonyl-5-fluorospiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(5-fluoro-1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;

16) N-[1(R)-[(1,2-Dihydro-1-(2-ethoxycarbonyl)methylsulfonylspiro[3H-indole-3,4'-piperidin]-1'-yl)carbonyl]-2-(1H-indol-3-yl)ethyl]-2-amino-2-methylpropanamide;

17) N-[1(R)-[(1,2-Dihydro-1,1-dioxospiro[3H-benzothiophene-3,4'-piperidin]-1'-yl)carbonyl]-2-(phenylmethyloxy)ethyl]-2-amino-2-methylpropanamide;

and pharmaceutically acceptable salts thereof.

The compounds of the invention may also be used in combination with bisphosphonates (bisphosphonic acids) and other agents, such as growth hormone secretagogues, e.g. MK-0677, for the treatment and the prevention of disturbances of calcium, phosphate and bone metabolism, in particular, for the prevention of bone loss during

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therapy with the GnRH antagonist, and in combination with estrogens, progesterones and or androgens for the prevention or treatment of bone loss or hypogonadal symptoms such as hot flashes during therapy with the GnRH antagonist.

Bisphosphonates (bisphosphonic acids) are known to inhibit bone resorption and are useful for the treatment of bone lithiasis as disclosed in U.S. Patent 4,621,077 to Rosini, et al.

The literature discloses a variety of bisphosphonic acids which are useful in the treatment and prevention of diseases involving bone resorption. Representative examples may be found in the following: U.S. Patent No. 3,251,907; U.S. Patent No. 3,422,137; U.S. Patent No. 3,584,125; U.S. Patent No. 3,940,436; U.S. Patent No. 3,944,599; U.S. Patent No. 3,962,432; U.S. Patent No. 4,054,598; U.S. Patent No. 4,267,108; U.S. Patent No. 4,327,039; U.S. Patent No. 4,407,761; U.S. Patent No. 4,578,376; U.S. Patent No. 4,621,077; U.S. Patent No. 4,624,947; U.S. Patent No. 4,746,654; U.S. Patent No. 4,761,406; U.S. Patent No. 4,922,007; U.S. Patent No. 4,942,157; U.S. Patent No. 5,227,506; U.S. Patent No. 5,270,365; EPO Patent Pub. No. 0,252,504; and J. Org. Chem., 36, 3843 (1971).

The preparation of bisphosphonic acids and halo-bisphosphonic acids is well known in the art. Representative examples may be found in the above mentioned references which disclose the compounds as being useful for the treatment of disturbances of calcium or phosphate metabolism, in particular, as inhibitors of bone resorption.

Preferred bisphosphonates are selected from the group of the following compounds: alendronic acid, etidrononic acid, clodronic acid, pamidronic acid, tiludronic acid, risedronic acid, 6-amino-1-hydroxy-hexylidene-bisphosphonic acid, and 1-hydroxy-3(methylpentylamino)-propylidene-bisphosphonic acid; or any pharmaceutically acceptable salt thereof. A particularly preferred bisphosphonate is alendronic acid (alendronate), or a pharmaceutically acceptable salt thereof. An especially preferred bisphosphonate is alendronate sodium, including alendronate sodium

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trihydrate. Alendronate sodium has received regulatory approval for marketing in the United States under the trademark FOSAMAX®.

Additionally, a compound of the present invention may be co-administered with a 5 α -reductase 2 inhibitor, such as finasteride or epristeride; a 5 α -reductase 1 inhibitor such as 4,7 β -dimethyl-4-aza-5 α -cholestan-3-one, 3-oxo-4-aza-4,7 β -dimethyl-16 β -(4-chlorophenoxy)-5 α -androstane, and 3-oxo-4-aza-4,7 β -dimethyl-16 β -(phenoxy)-5 α -androstane as disclosed in WO 93/23420 and WO 95/11254; dual inhibitors of 5 α -reductase 1 and 5 α -reductase 2 such as 3-oxo-4-aza-17 β -(2,5-trifluoromethylphenyl-carbamoyl)-5 α -androstane as disclosed in WO 95/07927; antiandrogens such as flutamide, casodex and cyproterone acetate, and alpha-1 blockers such as prazosin, terazosin, doxazosin, tamsulosin, and alfuzosin.

Further, a compound of the present invention may be used in combination with growth hormone, growth hormone releasing hormone or growth hormone secretagogues, to delay puberty in growth hormone deficient children, which will allow them to continue to gain height before fusion of the epiphyses and cessation of growth at puberty.

For combination treatment with more than one active agent, where the active agents are in separate dosage formulations, the active agents may be administered separately or in conjunction. In addition, the administration of one element may be prior to, concurrent to, or subsequent to the administration of the other agent.

The pharmaceutical compositions containing the active ingredient may be in a form suitable for oral use, for example, as tablets, troches, lozenges, aqueous or oily suspensions, dispersible powders or granules, emulsions, hard or soft capsules, or syrups or elixirs. Compositions intended for oral use may be prepared according to any method known to the art for the manufacture of pharmaceutical compositions and such compositions may contain one or more agents selected from the group consisting of sweetening agents, flavoring agents, coloring agents and preserving agents in order to provide pharmaceutically elegant and palatable preparations. Tablets contain the active ingredient in admixture with non-toxic pharmaceutically

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acceptable excipients which are suitable for the manufacture of tablets. These excipients may be for example, inert diluents, such as calcium carbonate, sodium carbonate, lactose, calcium phosphate or sodium phosphate; granulating and disintegrating agents, for example, corn starch, or alginic acid; binding agents, for example starch, gelatin or acacia, and lubricating agents, for example, magnesium stearate, stearic acid or talc. The tablets may be uncoated or they may be coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. For example, a time delay material such as glyceryl monostearate or glyceryl distearate may be employed. They may also be coated by the technique described in the U.S. Patent 4,256,108; 4,166,452; and 4,265,874 to form osmotic therapeutic tablets for control release.

Formulations for oral use may also be presented as hard gelatin capsules wherein the active ingredient is mixed with an inert solid diluent, for example, calcium carbonate, calcium phosphate or kaolin, or as soft gelatin capsules wherein the active ingredient is mixed with water or an oil medium, for example peanut oil, liquid paraffin, or olive oil.

Aqueous suspensions contain the active material in admixture with excipients suitable for the manufacture of aqueous suspensions. Such excipients are suspending agents, for example sodium carboxymethylcellulose, methylcellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinyl-pyrrolidone, gum tragacanth and gum acacia; dispersing or wetting agents may be a naturally-occurring phosphatide, for example lecithin, or condensation products of an alkylene oxide with fatty acids, for example polyoxyethylene stearate, or condensation products of ethylene oxide with long chain aliphatic alcohols, for example heptadecaethylene-oxycetanol, or condensation products of ethylene oxide with partial esters derived from fatty acids and a hexitol such as polyoxyethylene sorbitol monooleate, or condensation products of ethylene oxide with partial esters derived from fatty acids and hexitol anhydrides, for example polyethylene sorbitan

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monooleate. The aqueous suspensions may also contain one or more preservatives, for example ethyl, or n-propyl, p-hydroxybenzoate, one or more coloring agents, one or more flavoring agents, and one or more sweetening agents, such as sucrose, saccharin or aspartame.

Oily suspensions may be formulated by suspending the active ingredient in a vegetable oil, for example arachis oil, olive oil, sesame oil or coconut oil, or in mineral oil such as liquid paraffin. The oily suspensions may contain a thickening agent, for example beeswax, hard paraffin or cetyl alcohol. Sweetening agents such as those set forth above, and flavoring agents may be added to provide a palatable oral preparation. These compositions may be preserved by the addition of an anti-oxidant such as ascorbic acid.

Dispersible powders and granules suitable for preparation of an aqueous suspension by the addition of water provide the active ingredient in admixture with a dispersing or wetting agent, suspending agent and one or more preservatives. Suitable dispersing or wetting agents and suspending agents are exemplified by those already mentioned above. Additional excipients, for example sweetening, flavoring and coloring agents, may also be present.

The pharmaceutical compositions of the invention may also be in the form of an oil-in-water emulsions. The oily phase may be a vegetable oil, for example olive oil or arachis oil, or a mineral oil, for example liquid paraffin or mixtures of these. Suitable emulsifying agents may be naturally-occurring phosphatides, for example soy beans, lecithin, and esters or partial esters derived from fatty acids and hexitol anhydrides, for example sorbitan monooleate, and condensation products of the said partial esters with ethylene oxide, for example polyoxyethylene sorbitan monooleate. The emulsions may also contain sweetening and flavouring agents.

Syrups and elixirs may be formulated with sweetening agents, for example glycerol, propylene glycol, sorbitol or sucrose. Such formulations may also contain a demulcent, a preservative and flavoring and coloring agents.

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The pharmaceutical compositions may be in the form of a sterile injectable aqueous or oleagenous suspension. This suspension may be formulated according to the known art using those suitable dispersing or wetting agents and suspending agents which have been mentioned above. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example as a solution in 1,3-butane diol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil may be employed including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid find use in the preparation of injectables.

Compounds of Formula I may also be administered in the form of a suppositories for rectal administration of the drug. These compositions can be prepared by mixing the drug with a suitable non-irritating excipient which is solid at ordinary temperatures but liquid at the rectal temperature and will therefore melt in the rectum to release the drug. Such materials are cocoa butter and polyethylene glycols.

For topical use, creams, ointments, jellies, solutions or suspensions, etc., containing the compound of Formula I are employed. (For purposes of this application, topical application shall include mouth washes and gargles.)

The compounds for the present invention can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal routes, using those forms of transdermal skin patches well known to those of ordinary skill in the art. To be administered in the form of a transdermal delivery system, the dosage administration will, of course, be continuous rather than intermittent throughout the dosage regimen. Compounds of the present invention may also be delivered as a suppository employing bases such as cocoa butter, glycerinated gelatin, hydrogenated vegetable oils, mixtures of polyethylene glycols of various molecular weights and fatty acid esters of polyethylene glycol.

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The dosage regimen utilizing the compounds of the present invention is selected in accordance with a variety of factors including type, species, age, weight, sex and medical condition of the patient; the severity of the condition to be treated; the route of administration; the renal and hepatic function of the patient; and the particular compound thereof employed. A physician or veterinarian of ordinary skill can readily determine and prescribe the effective amount of the drug required to prevent, counter, arrest or reverse the progress of the condition. Optimal precision in achieving concentration of drug within the range that yields efficacy without toxicity requires a regimen based on the kinetics of the drug's availability to target sites. This involves a consideration of the distribution, equilibrium, and elimination of a drug. Preferably, doses of the compound of structural formula I useful in the method of the present invention range from 0.01 to 1000 mg per adult human per day. Most preferably, dosages range from 0.1 to 500 mg/day. For oral administration, the compositions are preferably provided in the form of tablets containing 0.01 to 1000 milligrams of the active ingredient, particularly 0.01, 0.05, 0.1, 0.5, 1.0, 2.5, 5.0, 10.0, 15.0, 25.0, 50.0, 100 and 500 milligrams of the active ingredient for the symptomatic adjustment of the dosage to the patient to be treated. An effective amount of the drug is ordinarily supplied at a dosage level of from about 0.0002 mg/kg to about 50 mg/kg of body weight per day. The range is more particularly from about 0.001 mg/kg to 10 mg/kg of body weight per day.

Advantageously, the active agent of the present invention may be administered in a single daily dose, or the total daily dosage may be administered in dividend doses of two, three or four times daily.

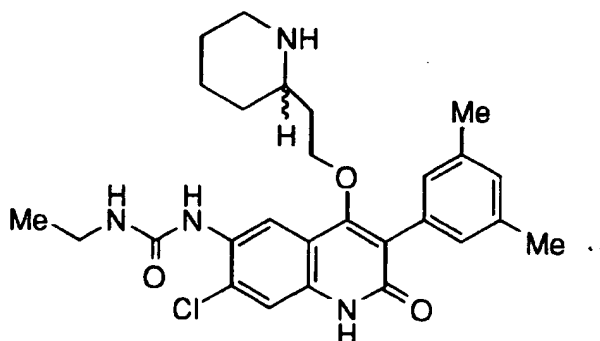
The amount of active ingredient that may be combined with the carrier materials to produce a single dosage form will vary depending upon the host treated and the particular mode of administration.

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It will be understood, however, that the specific dose level for any particular patient will depend upon a variety of factors including the age, body weight, general health, sex, diet, time of administration, route of administration, rate of excretion, drug combination and the severity of the particular disease undergoing therapy.

The following examples illustrate the preparation of some of the compounds of the invention and are not to be construed as limiting the invention disclosed herein.

EXAMPLE 1



1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-3-ethylurea

Step 1A 2-[2-[7-chloro-3-(3,5-dimethylphenyl)-6-(3-ethylureido)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid benzyl ester

To a solution of 2-{2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid benzyl ester (prepared essentially as described in Example 6, 158 mg in 4 mL dry methylene chloride) at 0° C was added phosgene (0.22 mL of a 1.93 M solution in toluene) followed by 0.081 mL of triethylamine and the mixture stirred for 1 hour at 0° C. At this

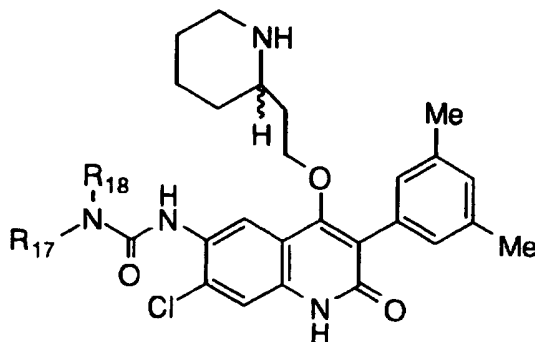
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time, 114.5 mg of ethylamine hydrochloride was added followed by additional triethylamine (0.195 mL) and the mixture allowed to warm to room temperature. After 20 hours, the mixture was diluted with ethyl acetate (200 mL) and the reaction quenched by the addition of water. The organic portion was washed sequentially with saturated sodium bicarbonate and brine. The solvent was removed *in vacuo* to provide the crude title compound (187 mg).

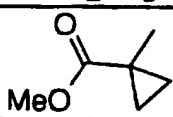
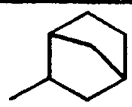
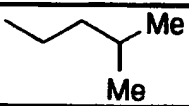

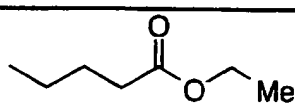
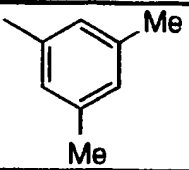
Step 1B 1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-3-ethylurea

A solution of 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-(3-ethylureido)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid benzyl ester (50 mg in 5 mL of a 30% solution of hydrobromic acid in acetic acid) was stirred at room temperature for 18 hours then concentrated *in vacuo*. The residue was treated with saturated sodium bicarbonate and then extracted with methylene chloride. Purification of the concentrate by flash chromatography on silica gel (methylene chloride:methanol:ammonium hydroxide, 96:3:1) gave the title compound (18 mg). MASS: 497 (M + H)

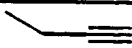

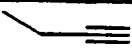
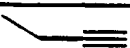
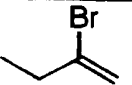
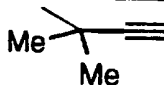
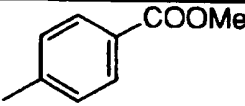
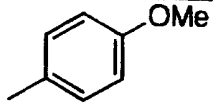
Following a procedure similar to that described above, the following compounds were prepared:



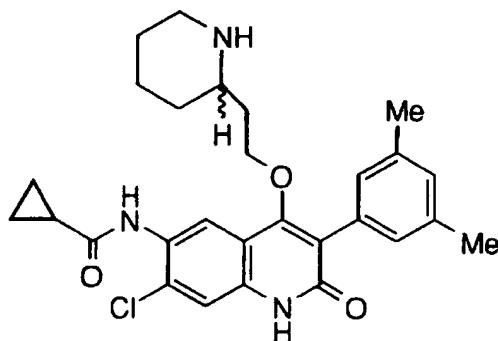
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Ex. #	R ₁₇	R ₁₈	m/e
1A	butyl	H	525 (M + H)
1B	propyl	H	511 (M + H)
1C	pentyl	H	539 (M + H)
1D	isopropyl	H	511 (M + H)
1E	isobutyl	H	525 (M + H)
1F	cyclohexyl	H	551 (M + H)
1G	cyclohexyl	Me	565 (M + H)
1H	-CH ₂ -cyclohexyl	H	565 (M + H)
1I	phenyl	H	545 (M + H)
1J	benzyl	H	559 (M + H)
1K	cyclobutyl	H	523 (M + H)
1L	cyclopentyl	H	537 (M + H)
1M	-CH ₂ -cyclopropyl	H	523 (M + H)
1N	-CH ₂ CF ₃	H	551 (M + H)
1O		H	567 (M + H)
1P	Me	H	483 (M + H)
1Q	Me	Me	497 (M + H)
1R		H	563 (M + H)
1S		H	539 (M + H)
1T		H	509 (M + H)
1U		H	583 (M + H)
1V		H	573 (M + H)

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1W		H	507 (M + H)
1X	-(CH ₂) ₂ OH	H	513 (M + H)
1Y	-(CH ₂) ₃ OH	H	527 (M + H)
1Z	cyclopropyl		553 (M + H)
1AA			545 (M + H)
1BB	-(CH ₂) ₄ OH	H	541 (M + H)
1CC	-(CH ₂) ₅ OH	H	555 (M + H)
1DD	(CH ₂) ₂ COOCH ₂ CH ₃	H	569 (M + H)
1EE	propyl	H	511 (M + H)
1FF	-(CH ₂) ₅ CH ₃	H	553 (M + H)
1GG	-CH ₂ CH(CH ₃) ₂	-CH ₂ CH(CH ₃) ₂	581 (M + H)
1HH	-CH ₂ COOH	H	527 (M + H)
1II	-CH ₂ COOMe	H	541 (M + H)
1JJ	-CH ₂ CH ₂ NHS(O ₂)- CH ₂ CH ₂ Si(Me) ₃	H	676 (M + H)
1KK		H	589 (M + H)
1LL	ethyl	ethyl	525 (M + H)
1MM	propyl	propyl	553 (M + H)
1NN		H	535 (M + H)
1OO	-(CH ₂) ₂ COOH	H	541 (M + H)
1PP		H	603 (M + H)
1QQ		H	575 (M + H)
1RR	H	H	

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EXAMPLE 2

Cyclopropanecarboxylic acid [7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-amide

Step 2A 2-{2-[7-chloro-6-(cyclopropanecarbonylamino)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (162 mg in 8 mL chlorobenzene) was added cyclopropanecarbonyl chloride (0.054 mL) and the mixture heated to 100° C. After 4 hours, the reaction was cooled and the solvent removed *in vacuo*. The residue was dissolved in methylene chloride and washed with saturated sodium bicarbonate. Concentration of the crude organics provided the title compound (80 mg).

Step 2B Cyclopropanecarboxylic acid [7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-amide

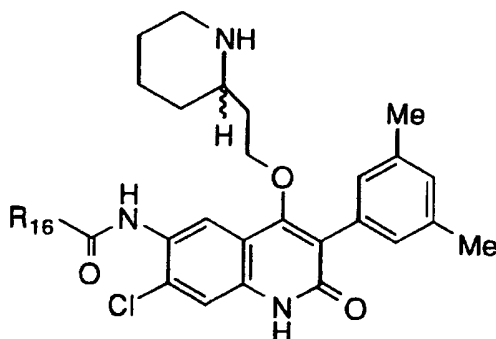
A solution of 2-{2-[7-chloro-6-(cyclopropanecarbonylamino)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (80 mg in a

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mixture of 8 mL trifluoroacetic acid and 0.03 mL anisole) was stirred at room temperature for 1 hour. The mixture was then concentrated *in vacuo*, resolvated in methylene chloride and washed with saturated sodium bicarbonate. The concentrated organics were purified by flash chromatography on silica gel (methylene chloride:methanol:ammonium hydroxide, 94:3:1) to give the title compound (52 mg).

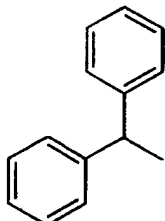
MASS: 494 (M + H)

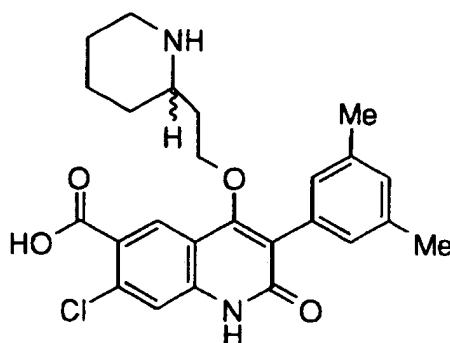
Following a procedure similar to that described above, the following compounds were prepared:



Example #	R ₁₆	m/e
2A	phenyl	530 (M + H)
2B	Me	468 (M + H)
2C	Me (S)-enantiomer	468 (M + H)
2D	propyl	496 (M + H)
2E	butyl	510 (M + H)
2F	pentyl	524 (M + H)
2G	isopropyl	496 (M + H)

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2H		620 (M + H)
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EXAMPLE 3.1

7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydro-quinoline-6-carboxylic acid

Step 3.1A 4-[2-(1-*tert*-butoxycarbonyl-piperidin-2-yl)-ethoxy]-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydro-quinoline-6-carboxylic acid

To a solution of 2-[2-[6-allyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester (prepared as described in Example 12, 517 mg in 35 mL of a mixture of *tert*-butanol:tetrahydrofuran:water, 10:3:1) was added 121 mg 4-methylmorpholine *N*-oxide and 48 mg osmium tetroxide and the mixture stirred at room temperature. After 2 hours, the reaction was diluted with 7.5 mL of water followed by the addition sodium periodate (602 mg) and sodium bicarbonate (946 mg) and the resulting suspension stirred rapidly for 90 minutes. The

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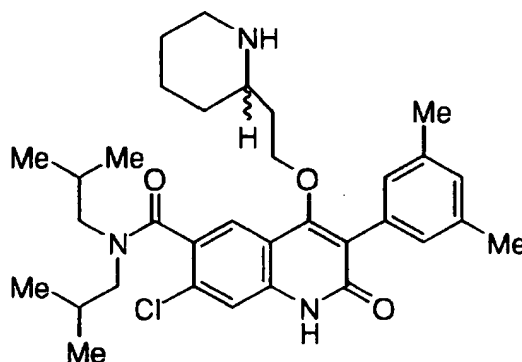
mixture was then filtered over diatomaceous earth and extracted with ethyl acetate. Concentration of the organics *in vacuo* provided the crude aldehyde product which was used in the following reaction without purification.

The crude product was solvated in 15 mL *tert*-butanol followed by the addition of sodium phosphate (8 mL of a 1.25 M aqueous solution) and potassium permanganate (15 mL of a 1 M aqueous solution) and the mixture stirred at room temperature. After 2 hours, the reaction was quenched by the addition of sodium sulfite, extracted with ethyl acetate, and the aqueous layer adjusted to pH3 with 1 N hydrochloric acid. The aqueous portion was extracted with ethyl acetate and the organics dried over magnesium sulfate. Purification of the concentrate by flash chromatography on silica gel (hexane:ethyl acetate, 7:3 + 1% acetic acid) provided the title compound (150 mg).

Step 3.1B 7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydro-quinoline-6-carboxylic acid

The title compound is prepared essentially as described in Example 2 (Step 2B).

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EXAMPLE 3.2

7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinoline-6-carboxylic acid diisobutylamide

Step 3.2A 2-[2-[7-chloro-6-diisobutylcarbonyl-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yl-ethoxy]-piperidine-1-carboxylic acid *tert*-butyl ester

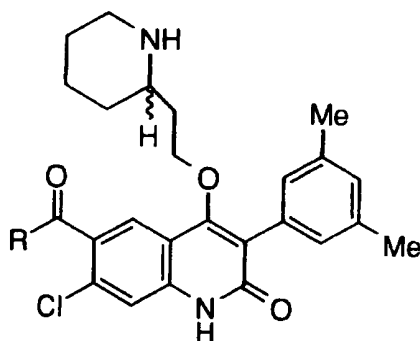
To a solution of 4-[2-(1-*tert*-butoxycarbonyl-piperidin-2-yl)-ethoxy]-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinoline-6-carboxylic acid (48 mg in 0.50 mL methylene chloride) was added 12 mg 1-hydroxybenzotriazole (HOBt) followed by 0.020 mL diisobutylamine, 0.025 mL triethylamine and 33 mg 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC) and the mixture stirred at room temperature. After 22 hours, the mixture was diluted with methylene chloride and washed with 10% aqueous sodium bisulfate and brine. The organics were dried over sodium sulfate and the concentrate purified by flash chromatography on silica gel (chloroform:methanol, 97.5:2.5) to give the title compound (37 mg).

Step 3.2B 7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinoline-6-carboxylic acid diisobutylamide

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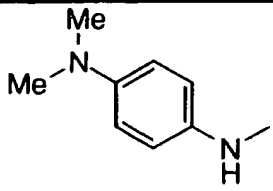
Prepared essentially as described in EXAMPLE 2, StepB from 37 mg of 2-{2-[7-chloro-6-diisobutylcarbamoyl-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester to give the title compound (33 mg).
 MASS: 566 (M + H)

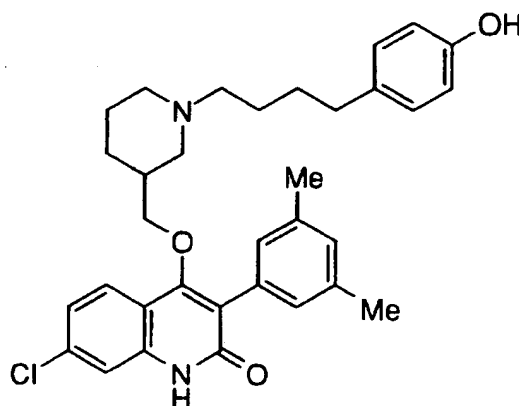
Following a procedure similar to that described above, the following compounds were prepared:



Example #	R	m/e
3A	Me-CH ₂ -CH ₂ -O	
3B	NH-cyclopropyl	
3C	(Et) ₂ N-	
3D		636 (M + H)
3E	 S-enantiomer	

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3F	 S-enantiomer	573 (M + H)
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EXAMPLE 4

7-chloro-3-(3,5-dimethylphenyl)-4-{1-[4-(4-hydroxyphenyl)-butyl]-piperidin-2-yl-methoxy}-1H-quinolin-2-one

Step 4A 7-chloro-3-(3,5-dimethylphenyl)-4-{1-[4-(4-methoxyphenyl)-butyl]-piperidin-2-yl-methoxy}-1H-quinolin-2-one

To a solution of 7-chloro-3-(3,5-dimethylphenyl)-4-(piperidin-2-yl-methoxy)-1H-quinolin-2-one (prepared essentially as described in Example 10, 34 mg in 3.0 mL dry methanol) was added 18 mg of 4-(4-methoxyphenyl)-butyraldehyde, 150 mg powdered 4Å molecular sieves and one drop of acetic acid. After 30 minutes, 0.13 mL of a 1M solution of sodium cyanoborohydride in tetrahydrofuran was added and the mixture stirred at room temperature for 18 hours. At this time the reaction mixture was filtered through diatomaceous

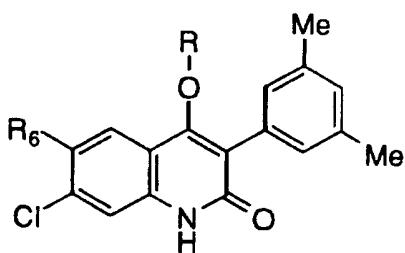
- 48 -

earth and the filtrate concentrated *in vacuo*. Purification by flash chromatography on silica gel (chloroform:methanolic ammonium hydroxide, 97:3) gave the title compound, 39 mg.

Step 4B 7-chloro-3-(3,5-dimethylphenyl)-4-{1-[4-(4-methoxyphenyl)-butyl]-piperidin-2-yl-methoxy}-1H-quinolin-2-one

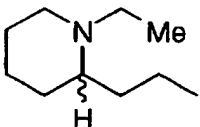
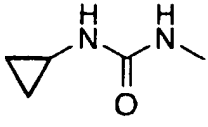
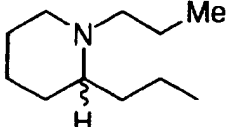
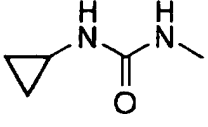
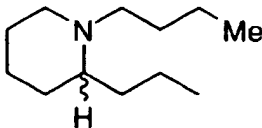
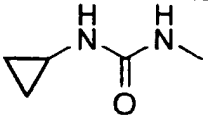
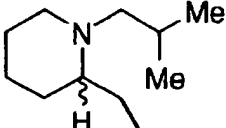
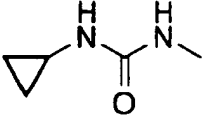
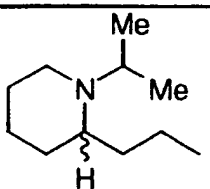
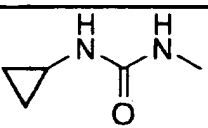
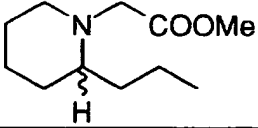
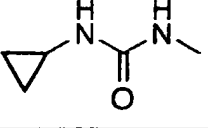
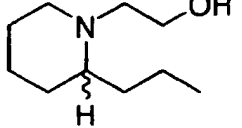
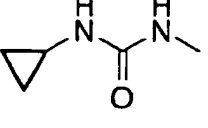
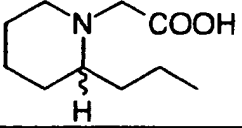
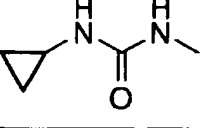
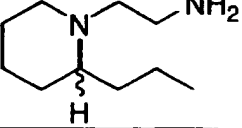
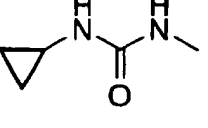
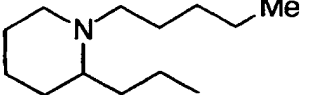
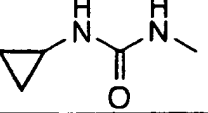
To a solution of 7-chloro-3-(3,5-dimethylphenyl)-4-{1-[4-(4-methoxyphenyl)-butyl]-piperidin-2-yl-methoxy}-1H-quinolin-2-one (30 mg in 2.0 mL of dry methylene chloride) was added boron tribromide and the mixture stirred at room temperature. After one hour the reaction was quenched by the addition of 10% aqueous sodium carbonate (15 mL) and extracted (3x) with chloroform. The combined organics were washed with brine, dried over sodium sulfate and purified by preparative tlc on silica gel (chloroform:methanolic ammonium hydroxide, 95:5) to give the title compound, 20 mg.

Following a procedure similar to that described above, the following compounds were prepared:

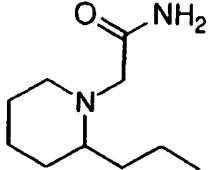
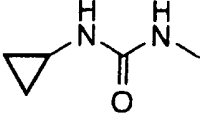
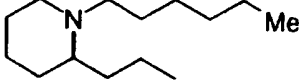
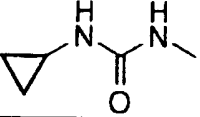
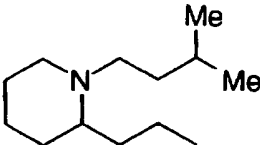
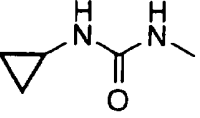
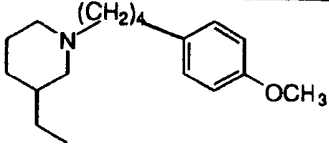
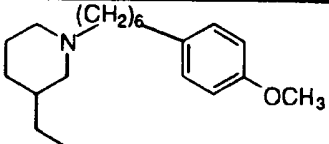
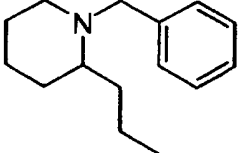
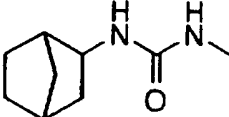
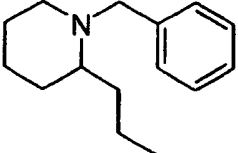
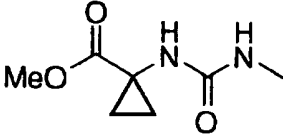
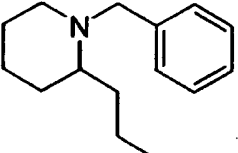
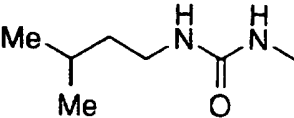


Ex. #	R	R ₆	m/e
4A			523 (M + H)

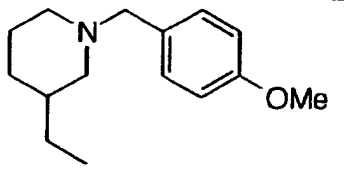
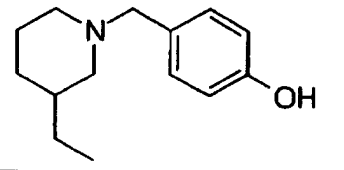
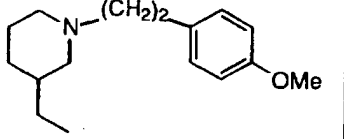
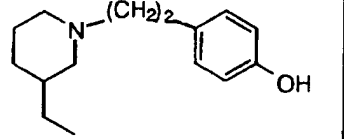
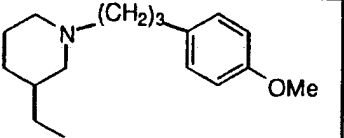
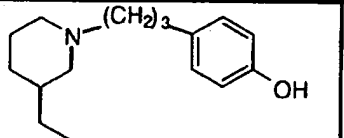
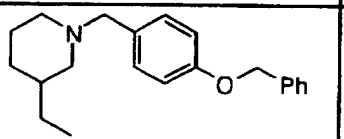
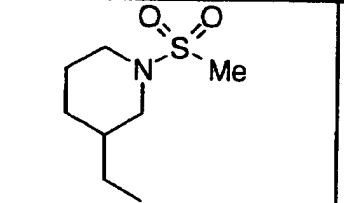
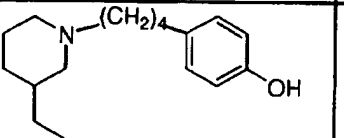
- 49 -

4B			537 (M + H)
4C			551 (M + H)
4D			565 (M + H)
4E			565 (M + H)
4F			551 (M + H)
4G			581 (M + H)
4H			553 (M + H)
4I			567 (M + H)
4J			511 (M + H)
4K			579 (M + H)

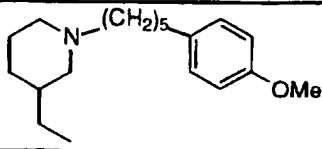
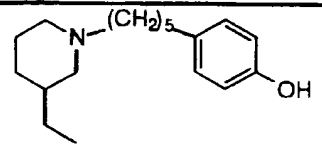
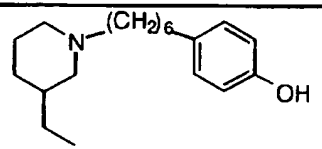
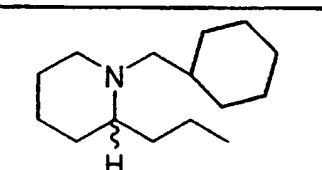
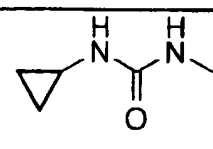
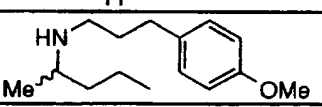
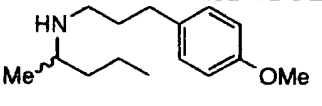
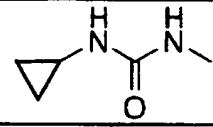
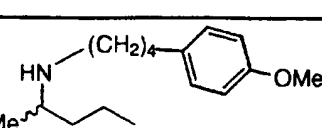
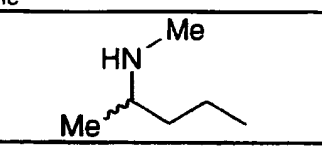
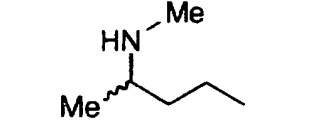
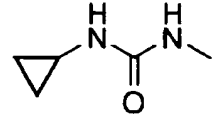
- 50 -

4L			566 (M + H)
4M			593 (M + H)
4N			579 (M + H)
4O		H	559 (M + H)
4P		H	587 (M + H)
4Q			
4R			
4S			

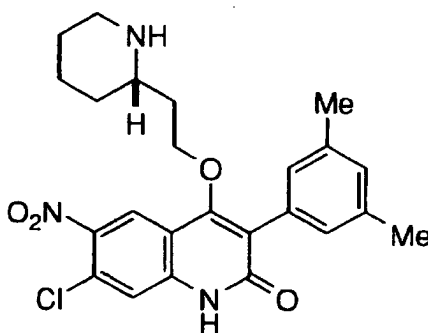
- 51 -

4T		H	517 (M + H)
4U		H	503 (M + H)
4V		H	531 (M + H)
4W		H	517 (M + H)
4X		H	543 (M + H)
4X		H	531 (M + H)
4Z		H	593 (M + H)
4AA		H	476 (M + H)
4BB		H	545 (M + H)

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4CC		H	573 (M + H)
4DD		H	559 (M + H)
4EE		H	573 (M + H)
4FF			605 (M + H)
4GG		NO ₂	565 (M + H)
4HH			617 (M + H)
4II		NO ₂	578 (M + H)
4JJ		NO ₂	430 (M + H)
4KK			483 (M + H)

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EXAMPLE 5

(S)-7-chloro-3-(3,5-dimethylphenyl)-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1H-quinolin-2-one

Step 5A (S)-2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of (S)-2-(2-hydroxyethyl)-piperidine-1-carboxylic acid *tert*-butyl ester (0.864 g in 38 mL dry tetrahydrofuran) was added 1.56g of 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-6-nitro-1H-quinolin-2-one [see Example 9] followed by 1.19 g of triphenylphosphine and the mixture stirred at room temperature. To this was added 0.72 mL of diethyl azodicarboxylate (DEAD) and stirring was continued for 64 hours. At this time the solvents were removed *in vacuo* and the residue purified by flash chromatography on silica gel (hexane:ethyl acetate, 6:4) to give the title compound, 1.56 g.

Step 5B (S)-7-chloro-3-(3,5-dimethylphenyl)-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1H-quinolin-2-one

To a solution of (S)-2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (35 mg in 2 mL dry

- 54 -

methylene chloride) was added 2 drops of anisole followed by 2 mL of trifluoroacetic acid and the mixture stirred at room temperature. After 30 minutes the solvents were removed *in vacuo*. The residue was azeotroped *in vacuo* successively from 2 mL carbon tetrachloride, 2 mL chloroform and 2 mL methylene chloride and the final concentrate purified by preparative tlc on silica gel (chloroform:10% ammonium hydroxide in methanol, 90:10) to give the title compound, 17 mg.

PREPARATION OF SYNTHETIC INTERMEDIATES

(S)-2-(2-hydroxyethyl)-piperidine-1-carboxylic acid *tert*-butyl ester

Step A: (S)-2-(diazoacetyl)piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of (S)-piperidine-1,2-dicarboxylic acid 1-*tert*-butyl ester (3.0 g in a mixture of 26 mL dry tetrahydrofuran and 26 mL dry diethyl ether) at -10° C was added 1.91 mL of triethylamine followed by the dropwise addition of 1.78 mL isobutyl chloroformate. The reaction was stirred at -10° C for 30 minutes then warmed to 0° C. Over the next hour, 26 mL of a solution of diazomethane in diethyl ether was added (prepared from: 8.0 g Diazald® in 70 mL diethyl ether; 4g potassium hydroxide; 20 mL 2-(2-ethoxyethoxy)ethanol; 6 mL water and 12 mL diethyl ether using a mini Diazald Kit) and the mixture allowed to stir at room temperature for an additional 2 hours. At this time the reaction was quenched by the addition of 3 mL acetic acid at 0° C. This was then diluted with 100 mL water and 100 mL diethyl ether, the layers separated and the aqueous portion extracted with (2x 75 mL) diethyl ether. The combined organics were washed with water (75 mL), saturated sodium bicarbonate (2x 75 mL) and brine (75 mL) then dried over magnesium sulfate. Removal of the solvent *in vacuo* and purification of the residue by flash chromatography on silica gel (hexane:ethyl acetate, 8:2) gave the title compound, 2.99 g.

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Step B: (S)-2-(methoxycarbonylmethyl)piperidine-1-carboxylic acid *tert*-butyl ester

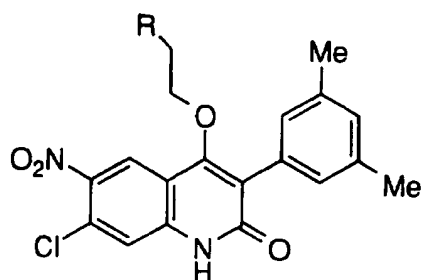
To a solution of (S)-2-(diazoacetyl)piperidine-1-carboxylic acid *tert*-butyl ester (5.90 g in 90 mL dry methanol) was added dropwise a solution of silver benzoate (265 mg in 3 mL triethylamine) and the mixture stirred at room temperature. After 2 hour, charcoal was added and the suspension filtered over diatomaceous earth. The mixture was concentrated *in vacuo* and the residue dissolved in ethyl acetate (400 mL), washed with water (2x 100 mL) and brine (150 mL). The organic portion was dried over magnesium sulfate and the concentrate purified by flash chromatography on silica gel (hexane:ethyl acetate, 8:2) to give the title compound (5.47 g).

Step C: (S)-2-(2-hydroxyethyl)-piperidine-1-carboxylic acid *tert*-butyl ester

To a slurry of lithium aluminum hydride (580 mg in 65 mL dry diethyl ether) at 0° C was added dropwise a solution of (S)-2-(methoxycarbonylmethyl)piperidine-1-carboxylic acid *tert*-butyl ester (5.47 g in 40 mL dry diethyl ether) over a period of 30 minutes. The reaction was allowed to continue at 0° C for an additional hour, at which time it was quenched by the careful addition of 0.58 mL water followed by 0.58 mL 2N sodium hydroxide and 1.8 mL water. The resulting suspension was stirred vigorously for 30 minutes then filtered through diatomaceous earth. The filtrate was concentrated *in vacuo* and the residue purified by flash chromatography on silica gel (hexane:ethyl acetate, 6:4) to give the title compound (4.61 g).

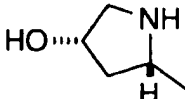
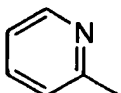
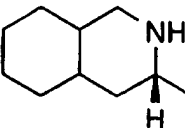
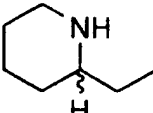
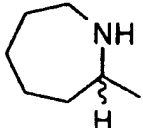
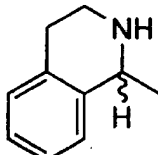
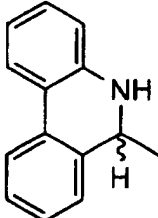
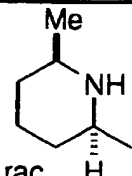
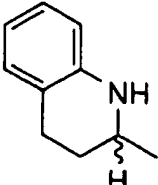
Following a procedure similar to that described above, the following compounds were prepared:

- 56 -

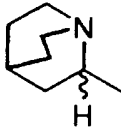
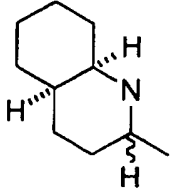
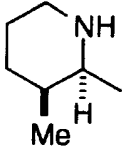
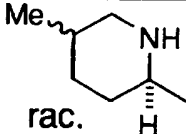
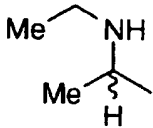
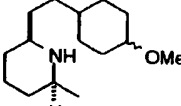
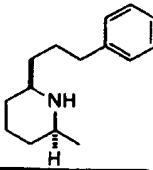
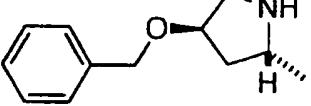
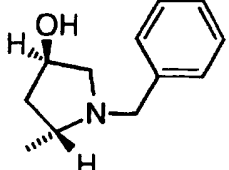


Example #	R	m/e
5A		
5B		428 (M + H)
5C		442 (M + H)
5D		456 (M + H)
5E		456 (M + H)
5F		458 (M + H)
5G		504 (M + H)

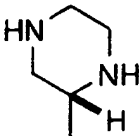
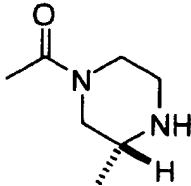
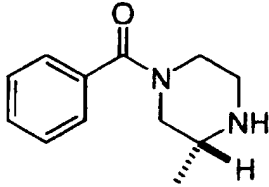
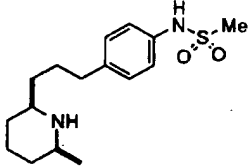
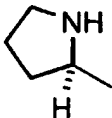
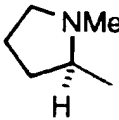
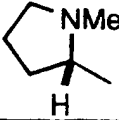
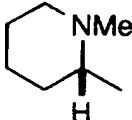
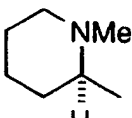
- 57 -

5H		458 (M + H)
5I		450 (M + H)
5J		510 (M + H)
5K		470 (M + H)
5L		470 (M + H)
5M		503 (M + H)
5N		550 (M + H)
5O		470 (M + H)
5P		504 (M + H)

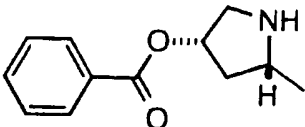
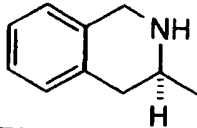
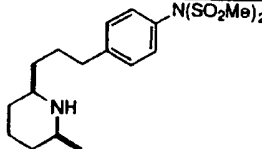
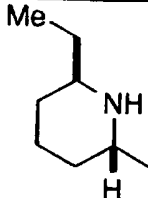
- 58 -

5Q		482 (M + H)
5R		510 (M + H)
5S		470 (M + H)
5T		470 (M + H)
5U		444 (M + H)
5V		596 (M + H)
5W		574 (M + H)
5X		548 (M + H)
5Y		548 (M + H)

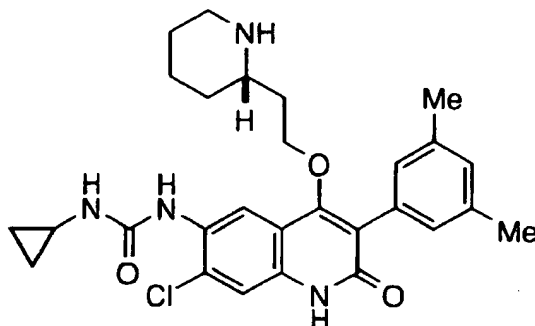
- 59 -

5Z		457 (M + H)
5AA		499 (M + H)
5BB		561 (M + H)
5CC		667 (M + H)
5DD		442 (M + H)
5EE		456 (M + H)
5FF		456 (M + H)
5GG		470 (M + H)
5HH		470 (M + H)

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5II		562 (M + H)
5JJ		504 (M + H)
5KK		745 (M + H)
5LL	 racemic	484 (M + H)

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EXAMPLE 6

(S)-1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-ylethoxy)-1,2-dihydroquinolin-6-yl]-3-cyclopropylurea

Step 6A (S)-2-[2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of (S)-2-[2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester (Example 5, Step 5A: 750 mg in 13 mL dry methanol) was added 18 mg iron(III)chloride hexahydrate followed by 100 mg activated carbon and the mixture heated to reflux on an oil bath. After 15 minutes, hydrazine (0.169 mL) was added dropwise and the reaction allowed to proceed at reflux for 12 hours. At this time, the mixture was cooled to room temperature, filtered through diatomaceous earth and the solvent removed *in vacuo*. The concentrate was solvated in 400 mL methylene chloride, washed successively with water (100 mL) and brine (100 mL), dried over sodium sulfate and concentrated *in vacuo* to give the title compound (crude: 710 mg).

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Step 6B (S)-2-{2-[7-chloro-6-(3-cyclopropylureido)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydro-quinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

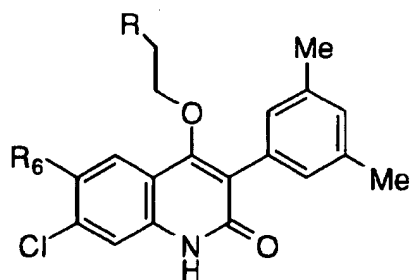
To a solution of (S)-2-{2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydro-quinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (700 mg in 13 mL dry methylene chloride) at 0° C was added 0.33 mL pyridine followed by 158 mg triphosgene and the mixture allowed to stir at 0° C for 1 hour. At this time 0.46 mL of cyclopropylamine was added via syringe and the reaction mixture warmed to room temperature. After 2 hours, the mixture was diluted with 200 mL ethyl acetate and washed with saturated ammonium chloride (100 mL) and brine (100 mL). The organic portion was dried over magnesium sulfate then concentrated *in vacuo*. The crude product was purified by crystallization from ethyl acetate to give the title compound (615 mg).

Step 6C (S)-1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-3-cyclopropylurea

To a solution of (S)-2-{2-[7-chloro-6-(3-cyclopropylureido)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydro-quinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (615 mg in 10 mL dry methylene chloride) was added 10 drops of anisole followed by 10 mL of trifluoroacetic acid and the mixture stirred at room temperature. After 1 hour the solvents were removed *in vacuo* and the resulting residue purified by flash chromatography on silica gel (chloroform:10% ammonium hydroxide in methanol, 90:10) to give the title compound (451 mg).

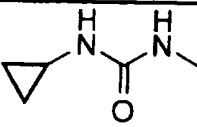
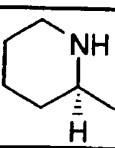
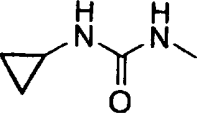
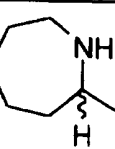
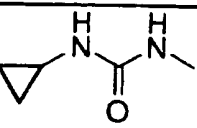
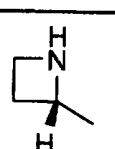
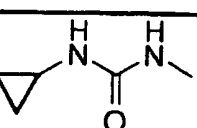
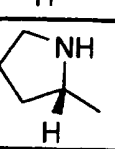
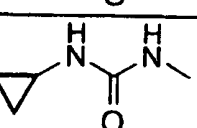
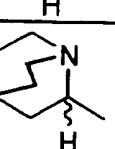
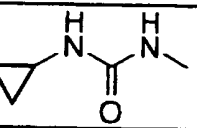
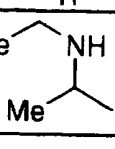
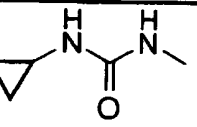
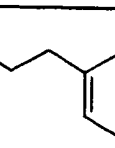
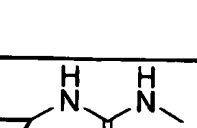
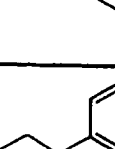
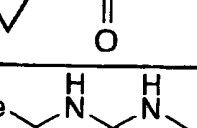
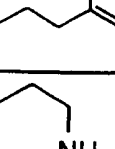
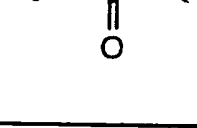
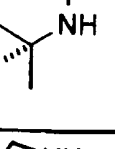
Following a procedure similar to that described above, the following compounds were prepared:

- 63 -

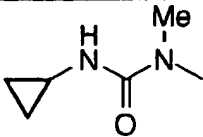
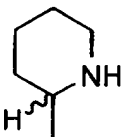


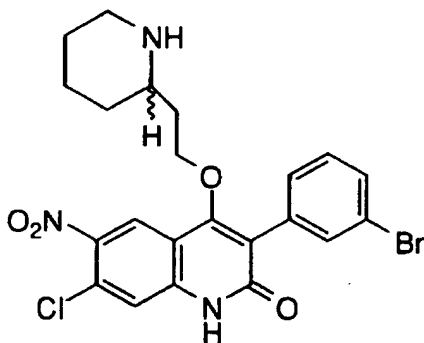
Ex. #	R ₆	R	m/e
6A			483 (M + H)
6B			497 (M + H)
6C			513 (M + H)
6D			509 (M + H)
6E			503 (M + H)
6F			503 (M + H)

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6G			509 (M + H)
6H			523 (M + H)
6I			481 (M + H)
6J			495 (M + H)
6K			535 (M + H)
6L			445 (M + H)
6M			591 (M + H)
6N			603 (M + H)
6O			497 (M + H)
6P			483 (M + H)

- 65 -

6Q			523 (M + H)
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EXAMPLE 7

3-(3-bromophenyl)-7-chloro-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1H-quinolin-2-one

Step 7A 2-[2-(3-bromophenyl)-acetylaminol]-4-chloro-5-nitro-benzoic acid methyl ester

To a suspension of 2-amino-4-chloro-5-nitrobenzoic acid methyl ester (Example 9, 780 mg in 10 mL dichloroethane) was added a solution of (3-bromophenyl)acetyl chloride (prepared essentially as described in Example 9, 866 mg in 5 mL dichloroethane) and the mixture heated to reflux on an oil bath. After 18 hours, the reaction mixture was concentrated *in vacuo* and the title compound obtained by crystallization from methanol (1.18 g).

Step 7B 3-(3-bromophenyl)-7-chloro-4-hydroxy-6-nitro-1H-quinolin-2-one

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To a solution of 2-[2-(3-bromophenyl)-acetylamino]-4-chloro-5-nitro-benzoic acid methyl ester (1.18 g in 15 mL dry tetrahydrofuran) at 0° C was added dropwise a solution of sodium bis(trimethylsilyl)amide (6.9 mL of a 1.0M solution in tetrahydrofuran) and the mixture warmed to room temperature. After 2 hours, the reaction was quenched by the addition of 200 mL iced 6N hydrochloric acid. The slurry was stirred for 10 minutes then filtered and washed (2x) with ice water and then cold acetonitrile. The residue was dried overnight at 45° C to give the title compound (887 mg).

Step 7C 2-{2-[3-(3-bromophenyl)-7-chloro-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

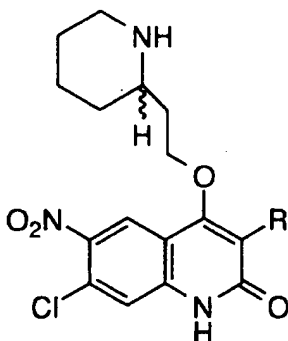
To a solution of 3-(3-bromophenyl)-7-chloro-4-hydroxy-6-nitro-1*H*-quinolin-2-one (100 mg in 4.0 mL of tetrahydrofuran) at 0° C was added 64 mg of 2-(2-hydroxyethyl)-piperidine-1-carboxylic acid *tert*-butyl ester and 93 mg of triphenylphosphine followed by 0.050 mL of diethyl azodicarboxylate and the mixture warmed to room temperature. After 20 hours, the solvents were removed *in vacuo* and the residue purified by flash chromatography on silica gel (hexane:ethylacetate, 2:1) to give the title compound (92 mg).

Step 7D 3-(3-bromophenyl)-7-chloro-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1*H*-quinolin-2-one

To a solution of 2-{2-[3-(3-bromophenyl)-7-chloro-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (33 mg in 1.5 mL methylene chloride) was added 2 drops of anisole followed by 1.5 mL of trifluoroacetic acid and the mixture stirred at room temperature. After 1 hour the solvents were removed *in vacuo* and the resulting residue purified by flash chromatography on silica gel (methylene chloride:methanol, 95:5) to give the title compound (24 mg).

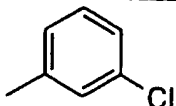
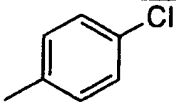
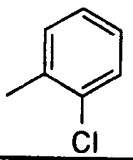
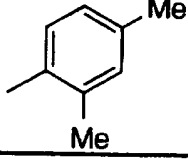
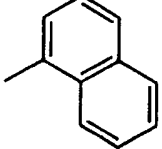
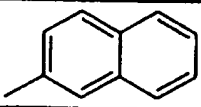
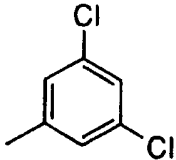
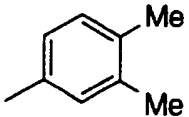
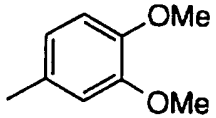
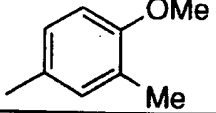
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Following a procedure similar to that described above, the following compounds were prepared:

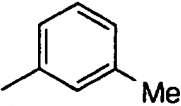
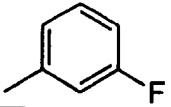
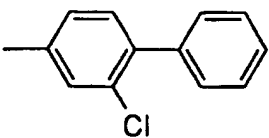
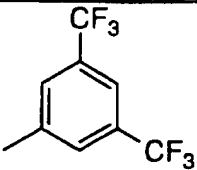
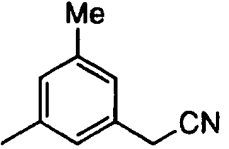
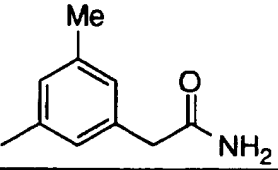
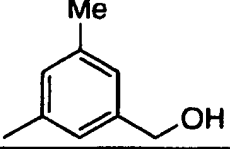
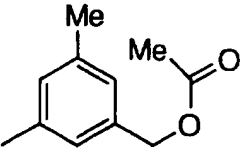
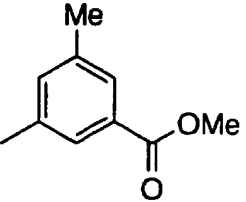


Example #	R	m/e
7A		
7B	phenyl	428 (M + H)
7C		
7D		
7E		
7F		

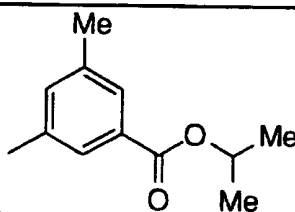
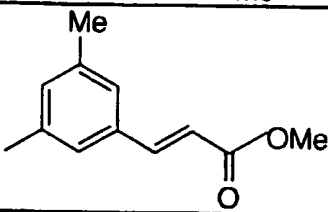
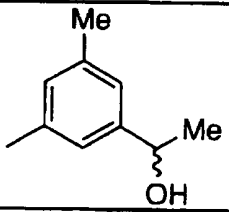
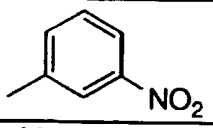
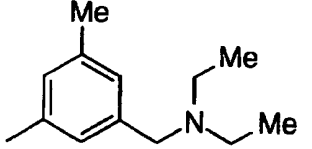
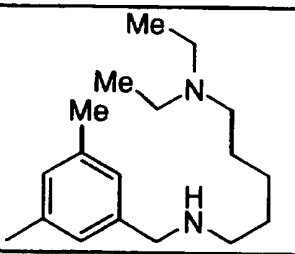
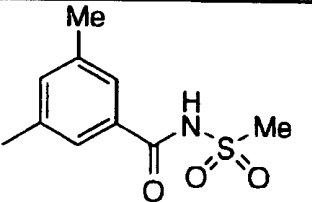
- 68 -

7G		
7H		
7I		
7J		
7K		
7L		
7M		496 (M + H)
7N		
7O		502 (M + H)
7P		

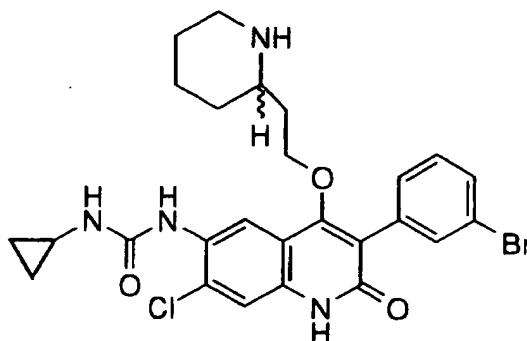
- 69 -

7Q		
7R		
7S		
7T		
7U		481 (M + H)
7V		499 (M + H)
7W		
7X		
7Y		

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7Z		
7AA		526 (M + H)
7BB		
7CC		
7DD		
7EE		612 (M + H)
7FF		563 (M + H)

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EXAMPLE 8

1-[3-(3-bromophenyl)-7-chloro-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-3-cyclopropyl urea

Step 8A 2-{2-[6-amino-3-(3-bromophenyl)-7-chloro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[3-(3-bromophenyl)-7-chloro-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (Example 8, 119 mg in 6 mL methanol) was added 4 mg iron(III)chloride hexahydrate followed by 25 mg activated carbon and the mixture heated to reflux on an oil bath. After 15 minutes, hydrazine (0.037 mL) was added dropwise and the reaction allowed to proceed at reflux for 3 hours. At this time, the mixture was cooled to room temperature, filtered through diatomaceous earth and the solvent removed *in vacuo*. The concentrate was solvated in 200 mL methylene chloride, washed successively with water (50 mL) and brine (50 mL), dried over sodium sulfate and concentrated *in vacuo* to give the title compound (crude: 87 mg).

Step 8B 2-{2-[3-(3-bromophenyl)-7-chloro-6-(3-cyclopropyl-ureido)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

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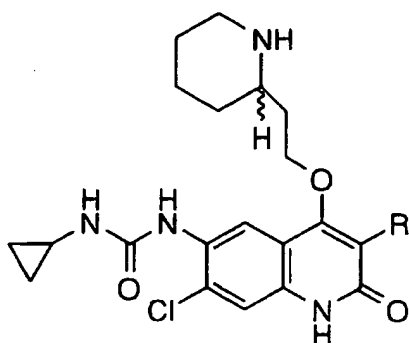
To a solution of 2-{2-[6-amino-3-(3-bromophenyl)-7-chloro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (20 mg in 1.0 mL methylene chloride) at 0° C was added 0.009 mL pyridine followed by 4 mg triphosgene and the mixture allowed to stir at 0° C for 1 hour. At this time 0.012 mL of cyclopropylamine was added via syringe and the reaction mixture warmed to room temperature. After 2 hours, the mixture was diluted with 20 mL ethyl acetate and washed with saturated ammonium chloride (10 mL) and brine (10 mL). The organic portion was dried over magnesium sulfate then concentrated *in vacuo*. The crude product was purified by flash chromatography on silica gel (hexane:ethyl acetate, 2:1; then 1:1; then 0:1) to give the title compound (14 mg).

Step 8C 1-[3-(3-bromophenyl)-7-chloro-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-3-cyclopropyl urea

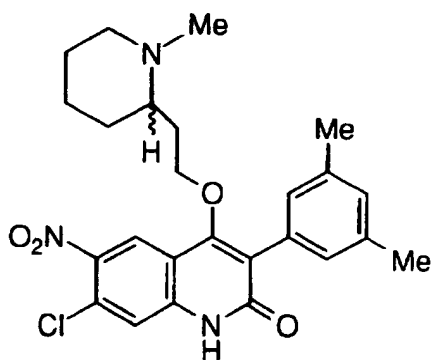
To a solution of 2-{2-[3-(3-bromophenyl)-7-chloro-6-(3-cyclopropyl-ureido)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (14 mg in 2.0 mL methylene chloride) was added 2 drops of anisole followed by 2.0 mL of trifluoroacetic acid and the mixture stirred at room temperature. After 30 minutes the solvents were removed *in vacuo* and the resulting residue purified by flash chromatography on silica gel (methylene chloride:methanol:ammonium hydroxide, 95:5:1; then 90:10:1) to give the title compound (6.0 mg).

Following a procedure similar to that described above, the following compounds were prepared:

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Example #	R
8A	
8B	
8C	
8D	

EXAMPLE 9

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7-chloro-3-(3,5-dimethylphenyl)-4-[2-(1-methylpiperidin-2-yl)-ethoxy]-6-nitro-1H-quinolin-2-one

Step 9A 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-5-nitrobenzoic acid methyl ester

To a suspension of 2-amino-4-chloro-5-nitrobenzoic acid methyl ester (989 mg in 15 mL of dry 1,2-dichloroethane) was added a solution of (3,5-dimethylphenyl)acetyl chloride (860 mg in 5 mL dry 1,2-dichloroethane) and the mixture heated at reflux on an oil bath. After 18 hours, an additional portion of (3,5-dimethylphenyl)acetyl chloride (274 mg in 1.5 mL dry 1,2-dichloroethane) was added and the mixture heated at reflux for an additional 5 hours. At this time the reaction was cooled and the solvent removed *in vacuo*. Recrystallization of the crude product from methanol gave the title compound (1.17 g).

Step 9B 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-6-nitro-1H-quinolin-2-one

To a solution of 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-5-nitrobenzoic acid methyl ester (1.17 g in 10 mL dry tetrahydrofuran) at 0° C was added dropwise a solution of sodium bis(trimethylsilyl)amide (7.8 mL of a 1.0M solution in tetrahydrofuran) and the mixture warmed to room temperature. After 2 hours, the reaction was quenched by the addition of 100 mL iced 6N hydrochloric acid. The slurry was stirred for 10 minutes then filtered and washed (2x) with ice water and then cold acetonitrile. The residue was dried overnight at 45° C to give the title compound (970 mg).

Step 9C 7-chloro-3-(3,5-dimethylphenyl)-4-[2-(1-methylpiperidin-2-yl)-ethoxy]-6-nitro-1H-quinolin-2-one

A mixture of 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-6-nitro-1H-quinolin-2-one (100 mg) and sodium bicarbonate (54 mg) was suspended in 2 mL dry *N,N*-dimethylformamide and heated to 80° C on an oil bath. After 30 minutes, sodium iodide (48 mg) was added

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followed by 2-(2-chloroethyl)-1-methylpiperidine hydrochloride (64 mg) and the mixture stirred at 80° C for 7 hours. At this time the reaction was cooled to room temperature and quenched by the addition of 25 mL ice/water. The mixture was filtered and the residue washed (1x) with ice water then dried at 40° C. Purification of the crude product by flash chromatography on silica gel (chloroform:10% ammonium hydroxide in methanol, 95:5) gave the title compound (67 mg).

PREPARATION OF SYNTHETIC INTERMEDIATES

2-amino-4-chloro-5-nitrobenzoic acid methyl ester

Step A: 2-acetylamino-4-chloro-5-nitrobenzoic acid methyl ester

To a solution of 3 mL conc. sulfuric acid and 0.40 mL of 90% nitric acid at 0° C was added 2-acetylamino-4-chlorobenzoic acid methyl ester (1.5 g) in three portions over a period of 20 minutes. This was stirred at 0° C for 30 minutes then allowed to warm to room temperature for an additional 1 hour. At this time the reaction was poured into 50 mL of an ice/water mixture and extracted with ethyl acetate (3x 50 mL). The combined organics were washed sequentially with water (2x 50 mL), 10% sodium bicarbonate (2x 50 mL) and brine (50 mL) then dried over magnesium sulfate and concentrated *in vacuo*. Recrystallization of the crude product from methanol gave the title compound (1.02 g).

Step B: 2-amino-4-chloro-5-nitrobenzoic acid methyl ester

To a solution of 2-acetylamino-4-chloro-5-nitrobenzoic acid methyl ester (1.02 g in 15 mL methanol) was added 1 mL of conc. sulfuric acid and the mixture heated to reflux on an oil bath. After 1 hour, the mixture was concentrated *in vacuo* and the resulting solid dissolved in 200 mL ethyl acetate. This was then washed with 10% sodium bicarbonate (2x 100 mL) and brine (100 mL) and the organics

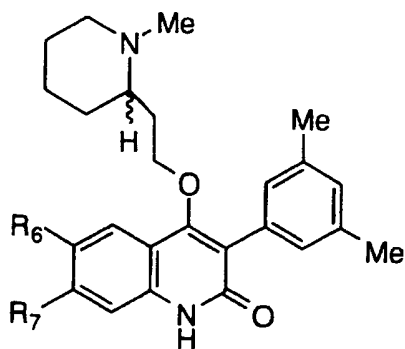
- 76 -

dried over magnesium sulfate. The concentrate was recrystallized from methanol to give the title compound (0.82 g).

(3,5-dimethylphenyl)acetyl chloride

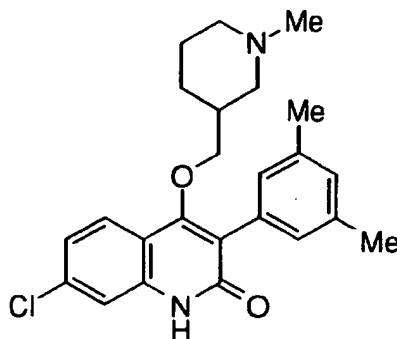
To a solution of (3,5-dimethylphenyl)acetic acid (2.32 g in 25 mL dry methylene chloride) at 0° C was added 0.055 mL *N,N*-dimethylformamide followed by the dropwise addition of 1.3 mL of oxalyl chloride. After 15 minutes the mixture was warmed to room temperature and stirred for an additional 2 hours. Removal of the solvents *in vacuo* provided the title compound which was used without purification.

Following a procedure similar to that described above, the following compounds were prepared:



Ex. #	R ₆	R ₇	m/e
9A	-H	-Cl	425 (M + H)
9B	-H	-CF ₃	459 (M + H)
9C	-H	-Br	469, 471 (M + H)
9D	-NO ₂	-CF ₃	490 (M + H)
9E	-NH-CO-NH-cyclopropyl	-CF ₃	543 (M + H)
9F	-cyano	-CF ₃	

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EXAMPLE 107-chloro-3-(3,5-dimethylphenyl)-4-(1-methyl-piperidin-3-ylmethoxy)-
1H-quinolin-2-oneStep 10A 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-benzoic
acid methyl ester

To a solution of (3,5-dimethylphenyl)acetyl chloride (2.58 g in 20 mL dry dichloroethane) was added 2.5 g 2-amino-4-chlorobenzoic acid methyl ester and the mixture heated to reflux on an oil bath. After 2 hours, the pot was cooled to room temperature and the solvent removed *in vacuo*. Recrystallization of the crude product from methanol gave the title compound (4.05 g).

Step 10B 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-1H-quinolin-2-
one

To a solution of 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-benzoic acid methyl ester (3.05 g in 20 mL dry tetrahydrofuran) at 0° C was added dropwise a solution of sodium bis(trimethylsilyl)amide (20 mL of a 1.0M solution in tetrahydrofuran) and the mixture warmed to room temperature. After 2 hours, the reaction was cooled to 0° C and quenched by the addition of 100 mL iced 6N hydrochloric acid. The slurry was stirred for 15 minutes then

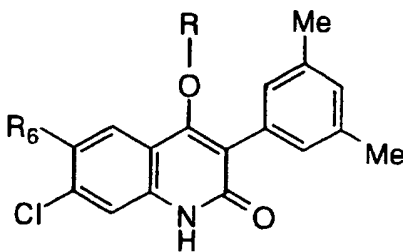
- 78 -

filtered and washed (2x) with ice cold acetonitrile. The residue was dried *in vacuo* overnight to give the title compound (2.3 g).

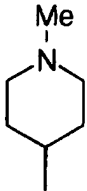
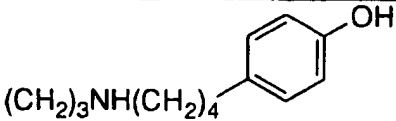
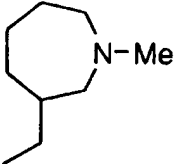
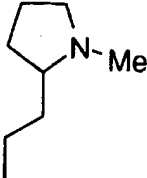
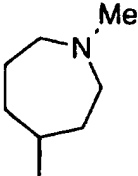
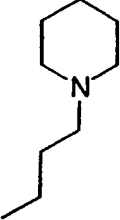
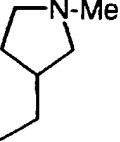
Step 10C 7-chloro-3-(3,5-dimethylphenyl)-4-(1-methyl-piperidin-3-ylmethoxy)-1H-quinolin-2-one

To a solution of 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-1H-quinolin-2-one (100 mg in 3 mL dry *N,N*-dimethylformamide) was added 68 mg 3-chloromethyl-1-methylpiperidine hydrochloride followed by 55 mg sodium iodide and 97 mg potassium carbonate and the mixture heated to 80° C on an oil bath. After 7 hours, an additional portion of potassium carbonate (48 mg) and 3-chloromethyl-1-methylpiperidine hydrochloride (68 mg) were added and the reaction allowed to proceed at 80° C for another 14 hours. At this time the reaction was cooled to room temperature and quenched by pouring into 25 mL of ice/water. The precipitate was collected by filtration and washed with cold water. Purification of the crude by flash chromatography on silica gel (chloroform:10% ammonium hydroxide in methanol, 95:5) provided the title compound (53 mg). MASS = 411 (M + H)

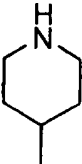
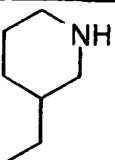
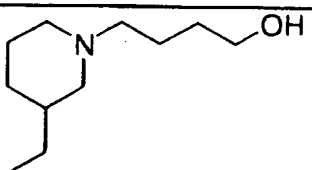
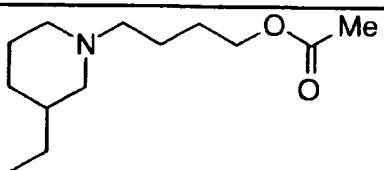
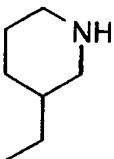
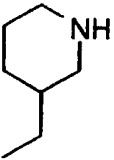
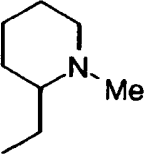
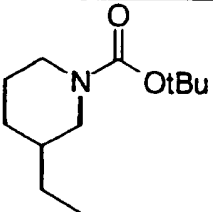
Following a procedure similar to that described above, the following compounds were prepared:



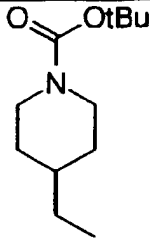
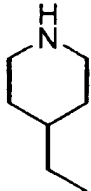
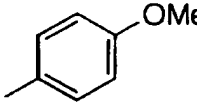
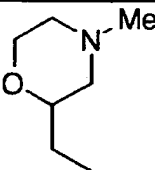
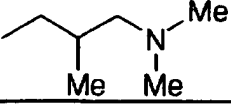
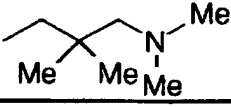
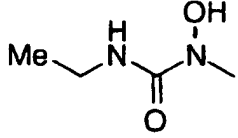
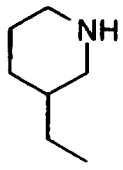
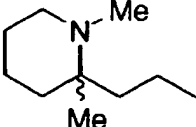
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Ex. #	R ₆	R	m/e
10A	H		397 (M + H)
10B	H		505 (M + H)
10C	H		425 (M + H)
10D	H		411 (M + H)
10E	H		411 (M + H)
10F	H		425 (M + H)
10G	H		397 (M + H)

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10H	H		397 (M + H)
10I	H	$-(\text{CH}_2)_3\text{N}(\text{CH}_3)_2$	
10J	H		397 (M + H)
10K	H		469 (M + H)
10L	H		511 (M + H)
10M	-NH-CO-Et		468 (M + H)
10N	-NO ₂		442 (M + H)
10O	H		411 (M + H)
10P	H		497 (M + H)

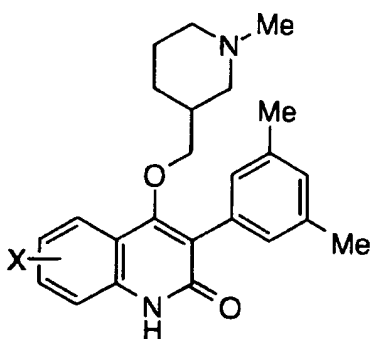
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10Q	H		497 (M + H)
10R	H		397 (M + H)
10S	H	$(\text{CH}_2)_3\text{NH}(\text{CH}_2)_4$ 	519 (M + H)
10T	H		413 (M + H)
10U	H		399 (M + H)
10V	H		413 (M + H)
10W			499 (M + H)
10X	NO ₂		484 (M + H)

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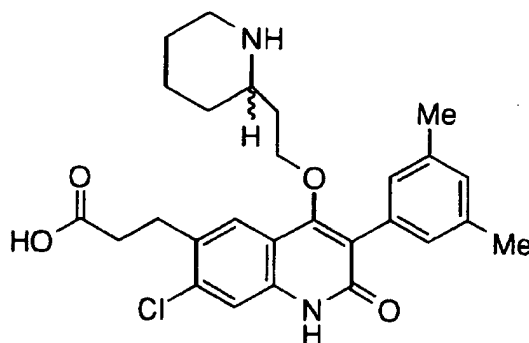
EXAMPLE 11

Following a procedure similar to that described in Example 10, the following compounds were prepared from the appropriately substituted anthranilic acid methyl esters:



Ex. #	X	
11A	7-NO ₂	422 (M + H)
11B	6-NO ₂	422 (M + H)
11C	7-COOMe	435 (M + H)
11D	6-Me	391 (M + H)
11E	6-Cl	411 (M + H)
11F	8-Cl	411 (M + H)
11G	5-Cl	411 (M + H)
11H	6-OMe	407 (M + H)
11I	7-F	395 (M + H)
11J	7-Me	391 (M + H)

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EXAMPLE 12.1

3-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-propionic acid

Step 12.1A 2-amino-4-chloro-5-iodo-benzoic acid methyl ester

To a suspension of 2-acetylamino-4-chlorobenzoic acid methyl ester (2.0 g in 80 mL of dry chloroform) and 2.5 g silver trifluoroacetate was added iodine (2.87 g in 40 mL chloroform) and the mixture stirred at room temperature. After 5 hours, the mixture was filtered over diatomaceous earth and the filtrate concentrated *in vacuo*. Purification of the resulting oil by flash chromatography on silica gel (hexane:ethyl acetate, 95:5; then 90:10) gave the title compound (2.26 g).

Step 12.1B 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-5-iodo-benzoic acid methyl ester

To a solution of 2-amino-4-chloro-5-iodo-benzoic acid methyl ester (2.26 g in 25 mL dichloroethane) was added (3,5-dimethylphenyl) acetyl chloride (1.2 g in 15 mL dichloroethane) and the mixture heated to 75° C on an oil bath. After 3 hours, the reaction was cooled and the solvent removed *in vacuo*. The title compound was isolated by crystallization from methanol (2.7 g).

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Step 12.1C 5-allyl-4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-benzoic acid methyl ester

To a suspension of 4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-5-iodo-benzoic acid methyl ester (2.39 g in 12 mL *N,N*-dimethylformamide) and 0.183 g bis(triphenylphosphine)palladium(II) chloride was added 2.02 mL allyltin and the mixture heated to 100° C on an oil bath. After 2 hours, the mixture was cooled, partitioned between ethyl acetate and water and the organic layer washed further with brine. Concentration of the dried (magnesium sulfate) organics and purification by flash chromatography on silica gel (hexane:ethyl acetate, 95:5; then 90:10) gave the title compound (1.4 g).

Step 12.1D 6-allyl-7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-1H-quinolin-2-one

To a solution of 5-allyl-4-chloro-2-[2-(3,5-dimethylphenyl)-acetylamino]-benzoic acid methyl ester (1.4 g in 40 mL dry tetrahydrofuran) at 0° C was added dropwise a solution of sodium bis(trimethylsilyl)amide (9.8 mL of a 1.0M solution in tetrahydrofuran) and the mixture warmed to room temperature. After 4 hours, the reaction was cooled to 0° C and quenched by the addition of 200 mL iced 6N hydrochloric acid. The slurry was stirred for 15 minutes then filtered and washed sequentially with ice water (500 mL), cold hexane (200 mL) and cold toluene (100 mL). The residue was dried *in vacuo* to give the title compound (960 mg).

Step 12.1E 2-[2-[6-allyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yl]oxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 6-allyl-7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-1H-quinolin-2-one (960 mg in 30 mL of tetrahydrofuran) at 0° C was added 615 mg of 2-(2-hydroxyethyl)-piperidine-1-carboxylic acid *tert*-butyl ester and 1.04 g of triphenylphosphine followed by 0.56 mL of diethyl azodicarboxylate and the mixture warmed to room temperature. After 20 hours, the solvents were removed *in vacuo* and

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the residue purified by flash chromatography on silica gel (hexane:ethyl acetate, 85:15; then 80:20; then 90:10) to give 1.19 g of the title compound.

Step 12.1F 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-(3-hydroxy-propyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[6-allyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (400 mg in 7.0 mL of dry tetrahydrofuran) at 0° C was added 2.18 mL of a 1M solution of borane in tetrahydrofuran dropwise over 10 minutes. After 3 hours, the reaction was treated sequentially with sodium hydroxide (0.84 mL of a 3M solution) and hydrogen peroxide (0.29 mL of a 30% solution) and the mixture allowed to warm to room temperature. After 2 hours the mixture was extracted with ethyl acetate, washed with brine and dried over sodium sulfate. Purification of the concentrate by flash chromatography on silica gel (hexane:ethyl acetate, 8:2; then 7:3; then 3:2; then 1:1) gave the title compound (253 mg).

Step 12.1G 2-{2-[6-(2-carboxyethyl)-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-(3-hydroxy-propyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (176 mg in 3.0 mL methylene chloride) was added 20 mg powdered 4Å sieves, 73 mg of 4-methylmorpholine-*N*-oxide, followed by 11 mg tetrapropylammonium perruthenate(VII) and the mixture stirred at room temperature. After 3 hours, the solvent was removed *in vacuo* and the crude aldehyde product resolvated in a mixture of *tert*-butanol (2 mL) and sodium phosphate (1 mL of a 1.25M solution). To this was added 1.86 mL of a 1M aqueous solution of potassium permanganate. After 30 minutes, the mixture was extracted with ethyl acetate, dried over sodium sulfate and purified by

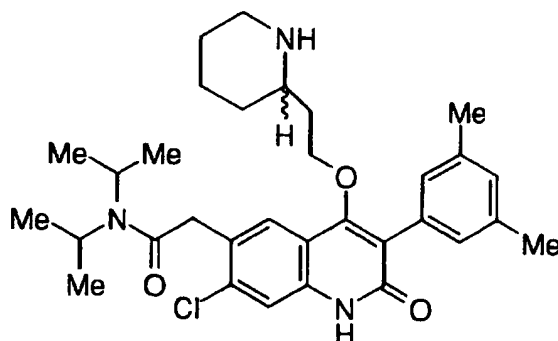
- 86 -

flash chromatography on silica gel (hexane:ethyl acetate, 1:1; then methylene chloride:methanol, 90:10) to give the title compound (107 mg).

Step 12.1H 3-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-propionic acid

Reaction conducted essentially as described in Example 8 (Step 8C) to provide the title compound. MASS: 482 (M + H)

EXAMPLE 12.2



2-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-N,N-diisopropylacetamide

Step 12.2A 2-[2-[7-chloro-6-(2,3-dihydroxypropyl)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-[2-[6-allyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl]-piperidine-1-carboxylic acid *tert*-butyl ester from EXAMPLE 12.1, Step E, 6.0 g in a mixture of 80 mL *tert*-butanol, 24 mL tetrahydrofuran and 8 mL water) was added 1.4 g 4-methylmorpholine *N*-oxide followed by 140 mg osmium tetroxide and the mixture stirred at room temperature. After 20 hours, the mixture was concentrated *in vacuo* and the residue dissolved in ethyl acetate and washed sequentially with water and brine.

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The combined organics were dried over sodium sulfate and purified by flash chromatography on silica gel (ethyl acetate:hexane, 1:1; then methylene chloride:10% ammonium hydroxide in methanol, 9:1) to give the title compound (5.7 g).

Step 12.2B 2-{2-[6-carboxymethyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of -{2-[7-chloro-6-(2,3-dihydroxypropyl)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (4.3 g in a mixture of 200 mL methanol and 3 mL pyridine) at 0 °C was added 7.4 g lead(IV) acetate in portions over 5 minutes and the mixture stirred at low temperature. After 10 minutes, the reaction was quenched by the addition of sodium sulfite and the mixture extracted with methylene chloride. The organic portion was washed with brine, dried over sodium sulfite and concentrated *in vacuo* to give the crude aldehyde intermediate.

The aldehyde was solvated in 200 mL *tert*-butanol and then 24 mL of a 1.25M solution of sodium dihydrogenphosphate was added followed by the dropwise addition of 44.5 mL of a 1M aqueous solution of potassium permanganate. After 2 hours, the reaction was quenched by the addition of saturated aqueous sodium sulfite. The pH of the solution was adjusted to 3 by the addition of 1N hydrochloric acid then the mixture was extracted with ethyl acetate, washed with brine and dried over sodium sulfate. Purification of the concentrate by flash chromatography on silica gel (ethyl acetate:hexane 3:7 + 1% acetic acid) gave the title compound (2.8 g).

Step 12.2C 2-{2-[7-chloro-6-[(diisopropylcarbamoyl)-methyl]-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[6-carboxymethyl-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-

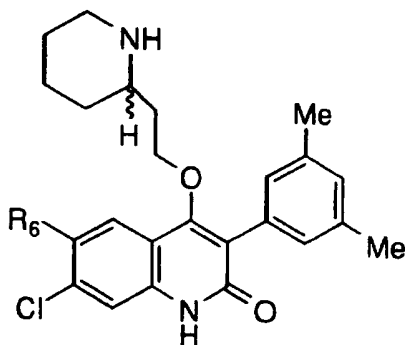
- 88 -

1-carboxylic acid *tert*-butyl ester (57 mg in 0.50 mL methylene chloride) was added 0.042 mL diisopropylamine followed by 98 mg 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC) and 6.1 mg dimethylaminopyridine, and the mixture stirred at room temperature. After 42 hours, the mixture was diluted with methylene chloride and washed with water and brine. The organics were dried over sodium sulfate and the concentrate purified by flash chromatography on silica gel (methylene chloride:methanol:ammonium hydroxide, 97:2:1) to give the title compound (41 mg).

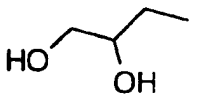
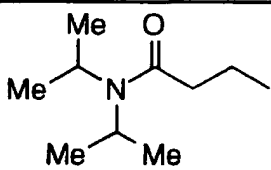
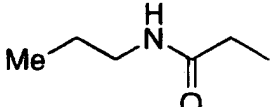
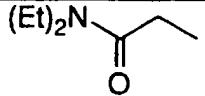
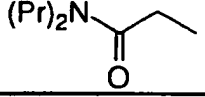
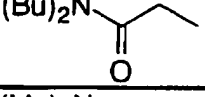
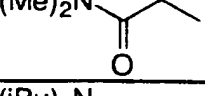
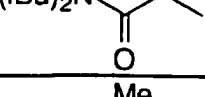
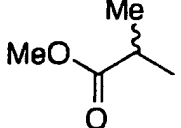
Step 12.2D 2-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethoxy)-1,2-dihydroquinolin-6-yl]-*N,N*-diisopropyl-acetamide

The title compound was prepared essentially as described in EXAMPLE 7, StepD from 41 mg of 2-{2-[7-chloro-6-[(diisopropylcarbamoyl)-methyl]-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester to give the final product (32 mg). MASS: 552 (M + H)

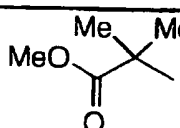
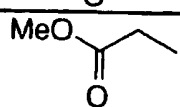
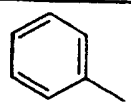
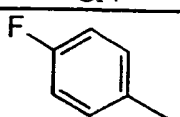
Following a procedure similar to that described above, the following compounds were prepared:



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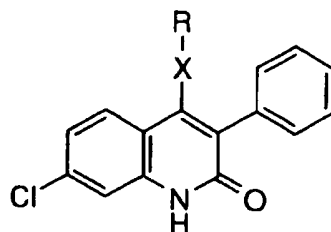
Ex. #	R ₆	m/e
12A	-NH-SO ₂ -phenyl	566 (M + H)
12B	-CH ₂ -CH=CH ₂	437 (M + H)
12C		485 (M + H)
12D	-(CH ₂) ₃ OH	469 (M + H)
12E	-CH ₂ -CO-Me	468 (M + H)
12F		566 (M + H)
12G	-NH-SO ₂ Me	
12H		496 (M + H)
12I	H ₂ C=CH-CH ₃	437 (M + H)
12J	HO-CH ₂ -CH ₂ -CH ₂ -CH ₃	455 (M + H)
12K		524 (M + H)
12L		552 (M + H)
12M		580 (M + H)
12N		496 (M + H)
12O		580 (M + H)
12P		497 (M + H)

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12Q		511 (M + H)
12R		483 (M + H)
12S	I	
12T		487 (M + H)
12U	-CN	
12V		

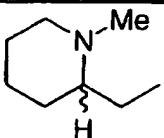
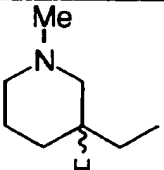
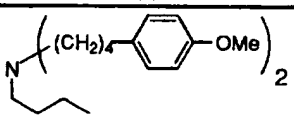
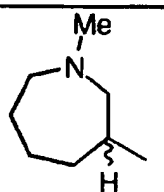
EXAMPLE 13

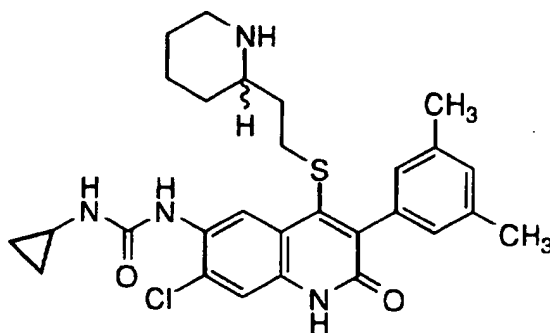
Following a procedure similar to that described in the EXAMPLES above, the following compounds were prepared:



Ex. #	R	X	m/e
13A	-(CH ₂) ₂ N(CH ₃) ₂	O	343 (M + H)
13B	-(CH ₂) ₃ NH ₂	O	329 (M + H)
13C	-(CH ₂) ₂ -Morpholine	NH	
13D	-(CH ₂) ₃ N(CH ₃) ₂	NH	
13E	-(CH ₂) ₂ N(CH ₃) ₂	NH	

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13F		O	383 (M + H)
13G		O	383 (M + H)
13H		O	652 (M + H)
13I		O	383 (M + H)

EXAMPLE 14

1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-ylethylsulfanyl)-1,2-dihydroquinolin-6-yl]-3-cyclopropyl urea

Step14A Trifluoromethanesulfonic acid 7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl ester

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To a solution of 7-chloro-3-(3,5-dimethylphenyl)-4-hydroxy-6-nitro-1*H*-quinolin-2-one (1.0 g in 50 mL dry methylene chloride) was added 0.455 ml diazabicycloundecene and the mixture cooled to -78° C. To this was added trifluoromethanesulfonic anhydride (0.51 mL) dropwise via syringe and the mixture stirred at low temperature. After 1 hour, the reaction was quenched by the addition of saturated ammonium chloride (35 mL) and extracted with ethyl acetate (3 x 75 mL). The organics were washed with water (50 mL) and brine (50 mL) then dried over magnesium sulfate. Purification of the concentrate by flash chromatography on silica gel (hexane:ethyl acetate, 3:2) gave the title compound (629 mg).

Step 14B 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester

To a solution of trifluoromethanesulfonic acid 7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl ester (524 mg in 4 mL dry *N,N*-dimethylformamide) at 0° C was added 0.38 mL diisopropylethylamine followed by 2-(2-mercaptoethyl)-piperidine-1-carboxylic acid benzyl ester (455 mg in 1 mL *N,N*-dimethylformamide) and the reaction allowed to warm to room temperature. After 1 hour, the mixture was diluted with ethyl acetate and water, and the layers separated. The organic portion was washed sequentially with water and brine then dried over magnesium sulfate. Purification of the concentrate by flash chromatography on silica gel (hexane:ethyl acetate, 7:3) gave the title compound (142 mg).

Step 14C 2-{2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester

To a solution of 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester (40 mg in 1.0 mL dry methanol) was added 2 mg iron(III)chloride hexahydrate followed by 2 mg activated carbon

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and the mixture heated to reflux on an oil bath. After 10 minutes, hydrazine (0.013 mL) was added dropwise and the reaction allowed to proceed at reflux for 1 hour. At this time, the mixture was cooled to room temperature, filtered through diatomaceous earth and the solvent removed *in vacuo*. The concentrate was solvated in methylene chloride, washed successively with water and brine (50 mL), dried over magnesium sulfate and concentrated *in vacuo* to give the title compound (crude: 24 mg).

Step 14D 2-{2-[7-chloro-6-(3-cyclopropylureido)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester

To a solution of 2-{2-[6-amino-7-chloro-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester (23 mg in 1.0 mL methylene chloride) at 0° C was added 0.01 mL pyridine followed by phosgene (0.03 mL of a 1.93M solution in toluene) and the mixture allowed to stir at 0° C for 1 hour. At this time 0.02 mL of cyclopropylamine was added via syringe and the reaction mixture warmed to room temperature. After 4 hours, the mixture was diluted with ethyl acetate and washed sequentially with 10% aqueous sodium bisulfate, water and brine. The organic portion was dried over magnesium sulfate then concentrated *in vacuo*. Purification of the crude material by flash chromatography on silica gel (chloroform:methanol, 95:5) gave the title compound (18 mg).

Step 14E 2-{2-[7-chloro-6-(3-cyclopropylureido)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester

A solution of 2-{2-[7-chloro-6-(3-cyclopropylureido)-3-(3,5-dimethylphenyl)-2-oxo-1,2-dihydroquinolin-4-ylsulfanyl]-ethyl}-piperidine-1-carboxylic acid benzyl ester (157 mg in 3.0 mL of 30% hydrobromic acid in acetic acid) was stirred at room temperature for 15 minutes. At this time the mixture was concentrated *in vacuo*, resolvated

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in methylene chloride, then washed sequentially with saturated sodium bicarbonate and brine. The organic portion was dried over sodium sulfate and purified by reverse-phase HPLC (65% water in acetonitrile w/ 0.1% trifluoroacetic acid) to give the title compound (119 mg).

Step 14F 1-[7-chloro-3-(3,5-dimethylphenyl)-2-oxo-4-(2-piperidin-2-yl-ethylsulfanyl)-1,2-dihydroquinolin-6-yl]-3-cyclopropyl urea

Reaction conducted essentially as described in Example 1 (Step 1B) to provide the title compound. MASS: 525 (M + H)

PREPARATION OF SYNTHETIC INTERMEDIATES

2-(2-mercaptoethyl)-piperidine-1-carboxylic acid benzyl ester

Step A: 2-(2-hydroxyethyl)-piperidine-1-carboxylic acid benzyl ester

To a solution of 2-piperidin-2-yl-ethanol (2.04 g in 50 mL methylene chloride) at 0° C was added 2.64 mL of triethylamine and 5 mg *N,N*-dimethylaminopyridine. To the stirred solution, 2.45 mL of benzyl chloroformate was added dropwise and the reaction allowed to proceed at room temperature. After 2 hours, the mixture was diluted with ethyl acetate and washed sequentially with 10% aqueous sodium bisulfate, water and brine. The organic portion was dried over magnesium sulfate and purified by flash chromatography on silica gel (hexane:ethyl acetate, 70:30) to give the title compound (2.05 g).

Step B: 2-(2-acetylsulfanylethyl)-piperidine-1-carboxylic acid benzyl ester

To a solution of triphenylphosphine (3.99 g in 35 mL dry tetrahydrofuran) was added 3.0 mL diisopropyl azodicarboxylate and the mixture stirred at 0° C for 30 minutes. At this time, 2.0 g of 2-(2-hydroxyethyl)-piperidine-1-carboxylic acid benzyl ester was added followed by the dropwise addition of a solution of 1.16 g thioacetic acid

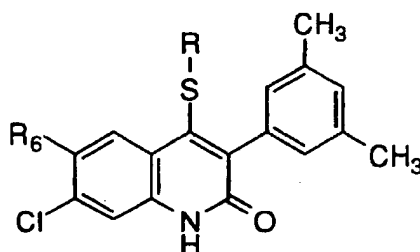
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in 19 mL tetrahydrofuran. After 2 hours, the mixture was concentrated *in vacuo* and purified by flash chromatography on silica gel (hexane:methylene chloride, 1:1) to give the title compound.

Step C: 2-(2-mercaptoethyl)-piperidine-1-carboxylic acid benzyl ester

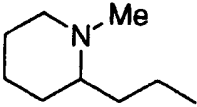
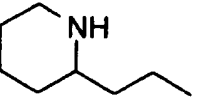
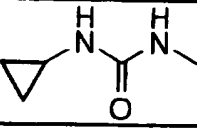
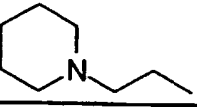
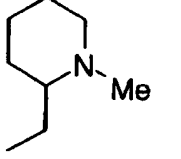
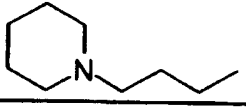
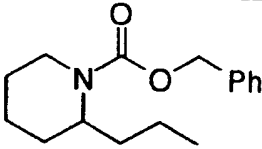
To a solution of 2-(2-acetylsulfanylethyl)-piperidine-1-carboxylic acid benzyl ester (174 mg in 5.0 mL methanol) was added 2.16 mL of a 0.5N solution of sodium hydroxide and the mixture stirred at room temperature for 30 minutes. At this time the reaction was diluted with ethyl acetate and quenched by the addition of 0.1N hydrochloric acid. The organic portion was washed sequentially with 0.1N hydrochloric acid, water and brine then dried over magnesium sulfate. Concentration *in vacuo* gave the crude title compound.

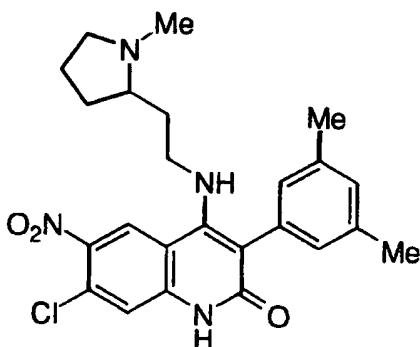
Following a procedure similar to that described above, the following compounds were prepared:



Ex. #	R	R ₆	m/e
14A		NO ₂	472 (M + H)
14B		NO ₂	472 (M + H)

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14C		NO ₂	486 (M + H)
14D	-(CH ₂) ₂ N(CH ₃) ₂	NO ₂	432 (M + H)
14E	-(CH ₂) ₂ NH ₂	NO ₂	404 (M + H)
14F			525 (M + H)
14G		NO ₂	472 (M + H)
14H		NO ₂	472 (M + H)
14G		NO ₂	486 (M + H)
14H		NO ₂	606 (M + H)

EXAMPLE 15

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7-chloro-3-(3,5-dimethylphenyl)-4-[2-(1-methylpyrrolidin-2-yl)-ethylamino]-6-nitro-1H-quinolin-2-one

Step 15A 4-amino-7-chloro-3-(3,5-dimethylphenyl)-6-nitro-1H-quinolin-2-one

To a solution of *N*-(5-chloro-2-cyano-4-nitrophenyl)-2-(3,5-dimethylphenyl)acetamide (prepared essentially as described in EXAMPLE 10, Step A, 250 mg in 7 mL *N,N*-dimethylformamide) was added 46 mg of 95% sodium hydride and the mixture stirred at room temperature. After 1.5 hours, the reaction mixture was diluted with ethyl acetate and quenched by the careful addition of 10% aqueous sodium bisulfate. The organics were then washed with brine and dried over sodium sulfate and concentrated *in vacuo*. The residue was suspended in methylene chloride and the solids collected by filtration and dried *in vacuo* to give the title compound (188 mg).

Step 15B *N*-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl]-2,2,2-trifluoroacetamide

To a suspension of 4-amino-7-chloro-3-(3,5-dimethylphenyl)-6-nitro-1H-quinolin-2-one (46 mg in a mixture of 1.0 mL methylene chloride and 1.5 mL pyridine) was added 0.020 mL trifluoroacetic anhydride and the mixture stirred at room temperature. After 30 minutes, the mixture was diluted with ethyl acetate and washed with water. The organic portion was washed with brine, dried over sodium sulfate and concentrated *in vacuo*. Recrystallization from warm methylene chloride gave the title compound (45 mg).

Step 15C *N*-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl]-2,2,2-trifluoro-*N*-[2-(1-methylpyrrolidin-2-yl)-ethyl]acetamide

To a suspension of 10 mg sodium hydride in 1.0 mL *N,N*-dimethylformamide was added 90 mg *N*-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl]-2,2,2-trifluoroacetamide and the mixture stirred at room temperature for 1

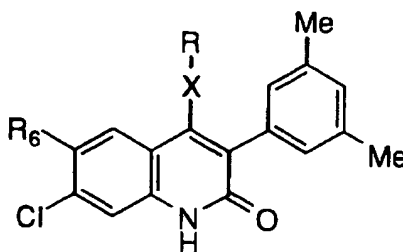
- 98 -

hour. At this time, 75 mg of 2-(2-chloroethyl)-1-methylpyrrolidine hydrochloride and the mixture heated to 80 °C on an oil bath. After 6 hours, the mixture was cooled to room temperature, diluted with ethyl acetate and extracted with water. The organic portion was washed with brine and dried over sodium sulfate. Purification of the concentrate by flash chromatography on silica gel (methylene chloride:methanol, 95:5 + 1% ammonium hydroxide) gave the title compound (50 mg).

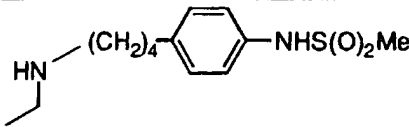
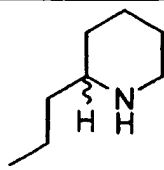
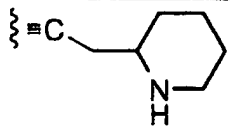
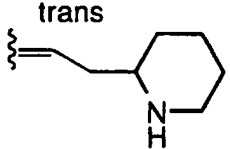

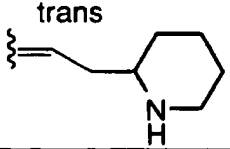

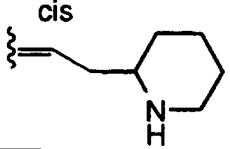

Step 15D 7-chloro-3-(3,5-dimethylphenyl)-4-[2-(1-methylpyrrolidin-2-yl)-ethylamino]-6-nitro-1H-quinolin-2-one

To a solution of *N*-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yl]-2,2,2-trifluoro-*N*-[2-(1-methylpyrrolidin-2-yl)-ethyl]acetamide (50 mg in a mixture of 1.0 mL methanol and 0.10 mL water) was added 25 mg potassium carbonate and the mixture heated to 60 °C. After 4 hours, the mixture was cooled to room temperature and the solvent removed *in vacuo*. The residue was dissolved in ethyl acetate and washed sequentially with water and brine then dried over sodium sulfate. Purification of the concentrate by flash chromatography on silica gel (chloroform:methanol:ammonium hydroxide, 90:10:1) gave the title compound (31 mg). MASS: 455 (M + H)

Following a procedure similar to that described above, the following compounds were prepared:



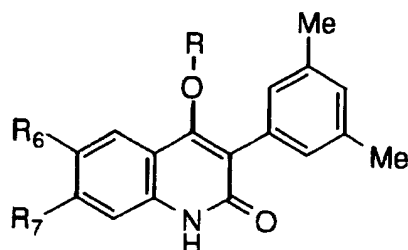
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Ex. #	R	X	R ₆	m/e
15A	H	NH	NO ₂	344 (M + H)
15B	-CH ₂ NH ₂	CH ₂	NO ₂	
15C	-CH ₂ OH	CH ₂	NO ₂	373 (M + H)
15D		CH ₂	NO ₂	597 (M + H)
15E		CH ₂	-NHC(O)- NH(cyclopropyl)	507 (M + H)
15F		-C≡	NO ₂	450 (M + H)
15G			NO ₂	452 (M + H)
15H			-NHC(O)- NH(cyclopropyl)	
15I			NO ₂	452 (M + H)

EXAMPLE 16

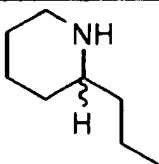
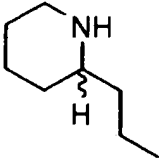
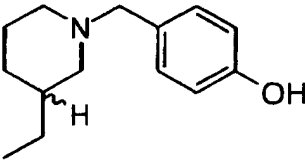
Following a procedure similar to that described in EXAMPLE 10, the following compounds were prepared:

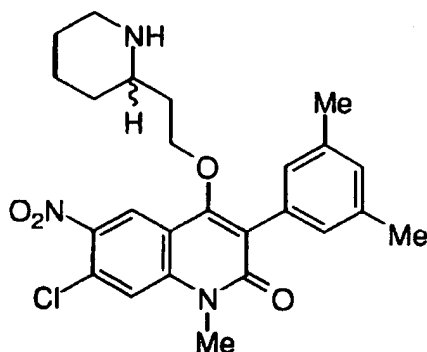
- 100 -



Ex. #	R ₆	R ₇	R	m/e
16A	H	NO ₂		530 (M + H)
16B	H			556 (M + H)
16C	NO ₂	H		530 (M + H)
16D		H		556 (M + H)
16E		H		

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16F	H	NO ₂		
16F	H	NH ₂		
16G	H	H		469 (M + H)

EXAMPLE 17

7-chloro-3-(3,5-dimethylphenyl)-1-methyl-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1H-quinolin-2-one

Step 17A 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-1-methyl-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester

To a solution of 2-{2-[7-chloro-3-(3,5-dimethylphenyl)-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl}-piperidine-1-carboxylic acid *tert*-butyl ester (100 mg in 3.5 mL *N,N*-

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dimethylformamide) at 0 °C was added 7.6 mg sodium hydride and the mixture stirred for 1 hour at low temperature. At this time, 0.012 mL iodomethane were added continued stirring. After 30 minutes, the reaction was quenched by the addition of saturated aqueous ammonium chloride and extracted with ethyl acetate. The organic portion was washed with water and brine then dried over magnesium sulfate to give the crude title compound.

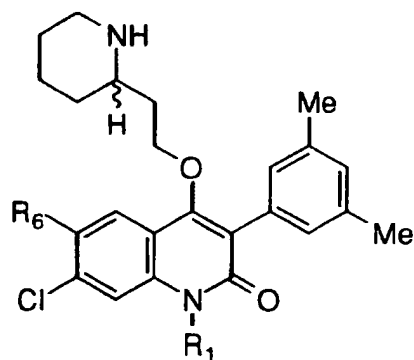
Step 17B 7-chloro-3-(3,5-dimethylphenyl)-1-methyl-6-nitro-4-(2-piperidin-2-yl-ethoxy)-1H-quinolin-2-one

A solution of 2-(2-[7-chloro-3-(3,5-dimethylphenyl)-1-methyl-6-nitro-2-oxo-1,2-dihydroquinolin-4-yloxy]-ethyl)-piperidine-1-carboxylic acid *tert*-butyl ester (ca. 100 mg crude from EXAMPLE 17, Step B) in a mixture of 1 mL trifluoroacetic acid and 0.01 mL anisole) was stirred at room temperature for 1 hour. The mixture was then concentrated *in vacuo*, resolvated in methylene chloride and washed with saturated sodium bicarbonate. The concentrated organics were purified by flash chromatography on silica gel (chloroform:1% ammonium hydroxide in methanol:, 9:1) to give the title compound (22 mg).

MASS: 470 (M + H)

Following a procedure similar to that described above, the following compounds were prepared:

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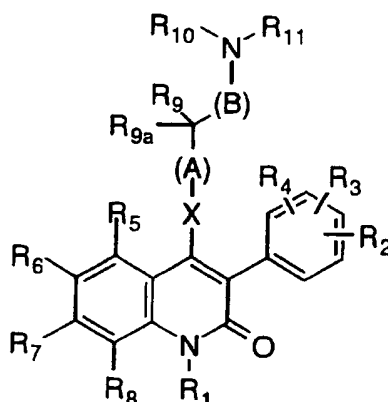


Ex. #	R ₆	R ₁	m/e
17A	NO ₂	-CH ₃	484 (M + H)

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WHAT IS CLAIMED IS:

1. A compound of the formula

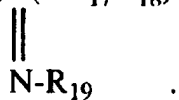


wherein:

- A is a bond, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, C₁-C₆ alkoxy, substituted C₁-C₆ alkoxy;
- B is a bond, C₁-C₆ alkyl, substituted C₁-C₆ alkyl;
- X is O, S, SO, SO₂, NR₁₂, C(R₁₃R₁₄), or can be absent;
- R₁ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₃-C₆ cycloalkyl, substituted C₃-C₆ cycloalkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₂, R₃ and R₄ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, CN, nitro, C₁-C₃ perfluoroalkyl, C₁-C₃ perfluoroalkoxy, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, R₁₅O(CR₁₃R₁₄)_p-, R₁₆C(O)O(CR₁₃R₁₄)_p-, R₁₅OC(O)(CR₁₃R₁₄)_p-, -(CR₁₃R₁₄)_pS(O)_nR₁₂, -(CR₁₃R₁₄)_pC(O)NR₁₇R₁₈, -(CR₁₃R₁₄)_pNR₁₇C(O)R₁₆, -(CR₁₃R₁₄)_pN(R₁₇R₁₈) or halogen;

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R₂ and R₃ taken together form a carbocyclic ring, saturated or unsaturated, of 3-7 carbon atoms or a heterocyclic ring containing 1-3 heteroatoms selected from N, O and S;
 R₅, R₆, R₇ and R₈, independently are H, halogen, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₂-C₆ alkenyl, substituted C₂-C₆ alkenyl, C₂-C₆ alkynyl, substituted C₂-C₆ alkynyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, C₁-C₃ perfluoroalkyl, C₁-C₃ perfluoroalkoxy, R₁₅O(CR₁₃R₁₄)_p-, -(CR₁₃R₁₄)_pCN, -(CR₁₃R₁₄)_pSO_nR₁₂, -(CR₁₃R₁₄)_pSO₂N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)C(O)R₁₆, -(CR₁₃R₁₄)_pN(R₁₇)C(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)SO₂N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)SO₂R₁₂, -(CR₁₃R₁₄)_pC(O)OR₁₅, -(CR₁₃R₁₄)_pOC(O)R₁₆, -(CR₁₃R₁₄)_pC(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pOC(O)N(R₁₇R₁₈), -(CR₁₃R₁₄)_pN(R₁₇)C(O)OR₁₅, or -(CR₁₃R₁₄)_pN(R₁₇)C(NR₁₇R₁₈)



R₉ and R_{9a} are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl; or

R₁₀ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl; or

R₁₁ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, -(CR₁₃R₁₄)_pC(O)OR₁₅; or

R₉ and R_{9a} can be taken together to form a carbocyclic ring, saturated or unsaturated, of 3-7 variously substituted carbon atoms, or;

R₉ and R₁₀ can be taken together to form a heterocyclic ring, saturated or unsaturated, of 4-7 atoms containing 1-3 heteroatoms selected from O, N, and S, or;

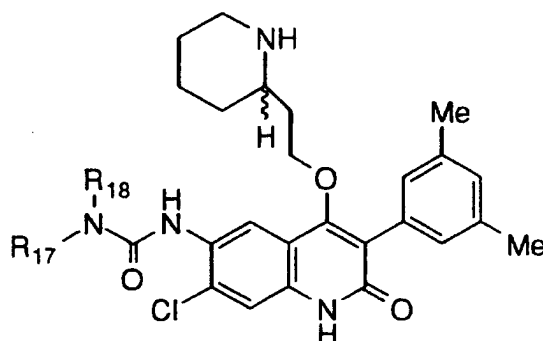
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- (R₉ and R₁₀) and (R_{9a} and R₁₁) can be taken together to form a heterobicyclic ring, with each ring being independently saturated or unsaturated, of 4-7 atoms containing 1-3 heteroatoms selected from O, N, and S;
- R₁₂ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₃ and R₁₄ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₅ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₆ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl;
- R₁₇ and R₁₈ are independently H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl, C₃-C₆ cycloalkyl, substituted C₃-C₆ cycloalkyl, aryl, substituted aryl, C₁-C₆ aralkyl, substituted C₁-C₆ aralkyl, or taken together form a carbocyclic ring(s) of 4-7 carbon atoms each;
- R₁₉ is H, C₁-C₆ alkyl, substituted C₁-C₆ alkyl or -CN;
- n is 0, 1, or 2;
- p is 0, 1, 2, 3 or 4
- the alkyl, cycloalkyl, alkenyl and alkynyl substituents are selected from C₁-C₆ alkyl, C₃-C₇ cycloalkyl, aryl, substituted aryl, aralkyl, substituted aralkyl, hydroxy, oxo, cyano, C₁-C₆ alkoxy, fluoro, C(O)OR₁₁, aryl C₁-C₃ alkoxy, substituted aryl C₁-C₃ alkoxy, and the aryl substituents are as defined for R₃, R₄ and R₅;

or a pharmaceutically acceptable addition salt and/or hydrate thereof, or where applicable, a geometric or optical isomer or racemic mixture thereof.

2. The compound of Claim 1 of the structural formula

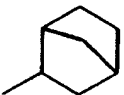
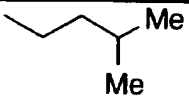
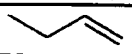
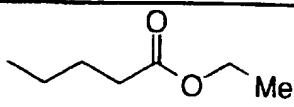
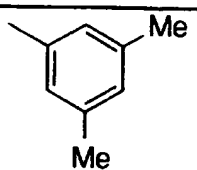
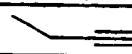

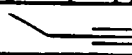
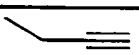
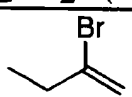
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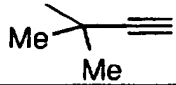
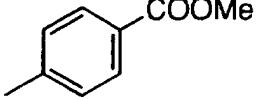
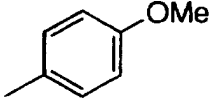
wherein R₁₇ and R₁₈ are as indicated in the table below:

Ex. #	R ₁₇	R ₁₈
1A	butyl	H
1B	propyl	H
1C	pentyl	H
1D	isopropyl	H
1E	isobutyl	H
1F	cyclohexyl	H
1G	cyclohexyl	Me
1H	-CH ₂ -cyclohexyl	H
1I	phenyl	H
1J	benzyl	H
1K	cyclobutyl	H
1L	cyclopentyl	H
1M	-CH ₂ -cyclopropyl	H
1N	-CH ₂ CF ₃	H
1O		H
1P	Me	H
1Q	Me	Me

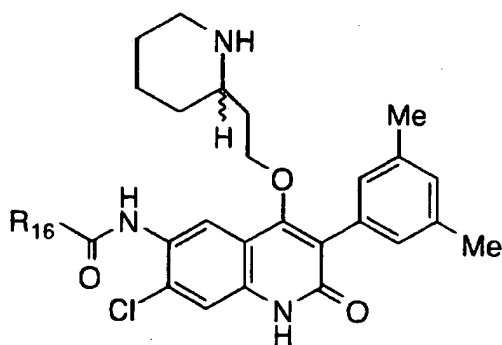
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1R		H
1S		H
1T		H
1U		H
1V		H
1W		H
1X	$-(\text{CH}_2)_2\text{OH}$	H
1Y	$-(\text{CH}_2)_3\text{OH}$	H
1Z	cyclopropyl	
1AA		
1BB	$-(\text{CH}_2)_4\text{OH}$	H
1CC	$-(\text{CH}_2)_5\text{OH}$	H
1DD	$(\text{CH}_2)_2\text{COOCH}_2\text{CH}_3$	H
1EE	propyl	H
1FF	$-(\text{CH}_2)_5\text{CH}_3$	H
1GG	$-\text{CH}_2\text{CH}(\text{CH}_3)_2$	$-\text{CH}_2\text{CH}(\text{CH}_3)_2$
1HH	$-\text{CH}_2\text{COOH}$	H
1II	$-\text{CH}_2\text{COOMe}$	H
1JJ	$-\text{CH}_2\text{CH}_2\text{NHS}(\text{O}_2)-$ $\text{CH}_2\text{CH}_2\text{Si}(\text{Me})_3$	H
1KK		H
1LL	ethyl	ethyl
1MM	propyl	propyl

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INN		H
100	$-(\text{CH}_2)_2\text{COOH}$	H
1PP		H
1QQ		H
1RR	H	H
1SS	ethyl	H

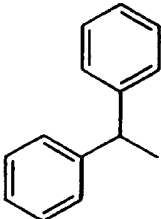
3. The compound of Claim 1 of the structural formula



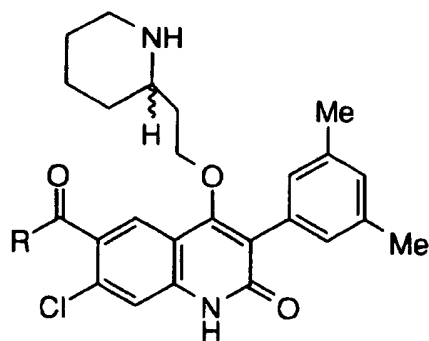
wherein R_{16} is as indicated in the table below:

R_{16}
cyclopropyl
phenyl
Me
Me
(S)-enantiomer

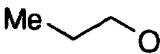
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propyl
butyl
pentyl
isopropyl


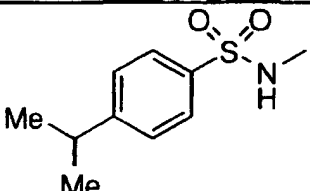
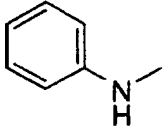
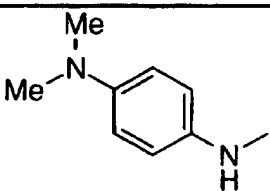
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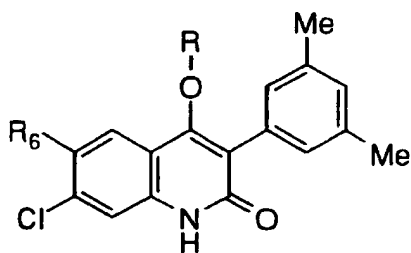
wherein R is as indicated in the table below:

Example #	R
3A	
3B	NH-cyclopropyl
3C	N(iBu) ₂
3D	N(Et) ₂

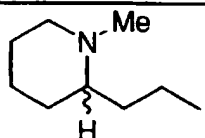
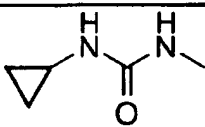
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3E	
3F	 S-enantiomer
3G	 S-enantiomer

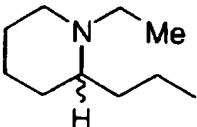
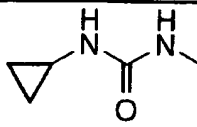
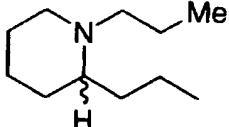
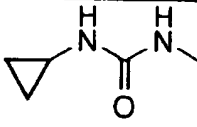
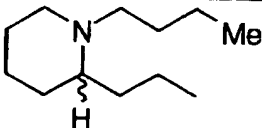
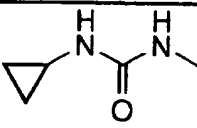
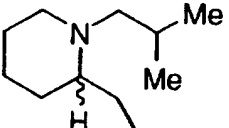
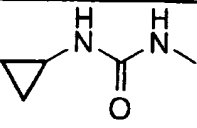
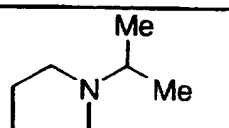
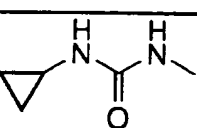
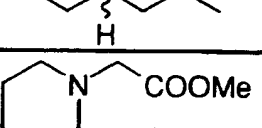
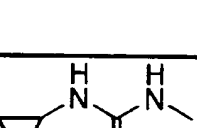
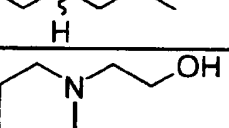
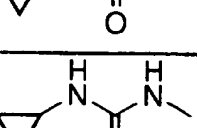
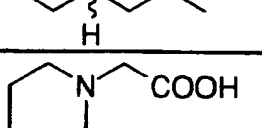
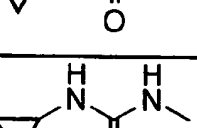
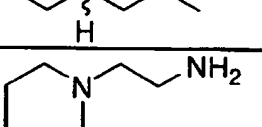
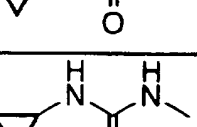
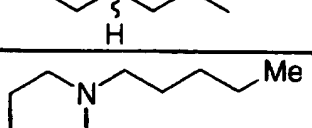
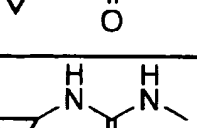
5. The compound of Claim 1 of the structural formula



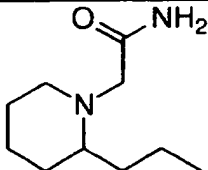
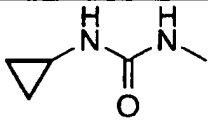
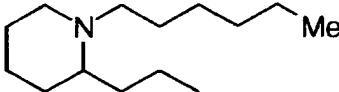
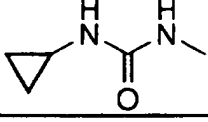
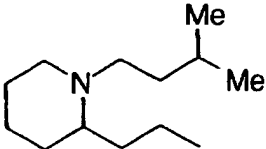
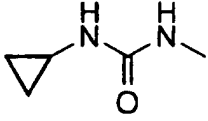
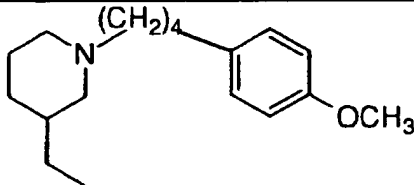
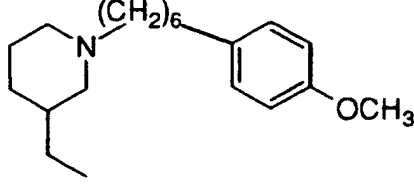
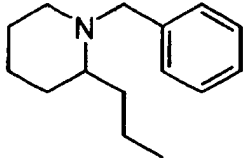
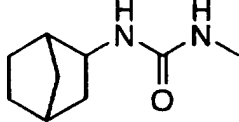
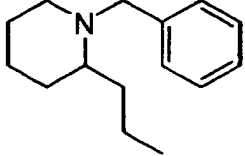
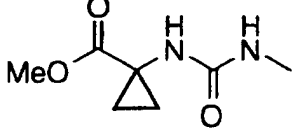
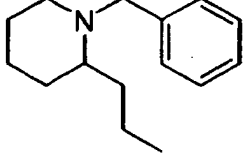
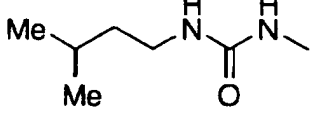
wherein R and R₆ are as indicated in the table below:

Ex. #	R	R ₆
4A		

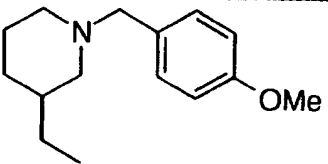
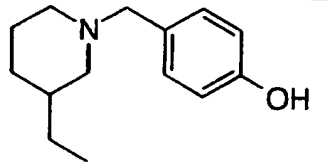
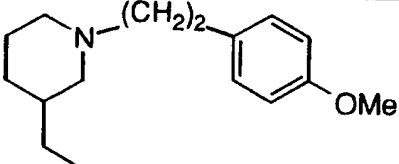
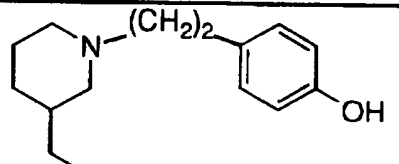
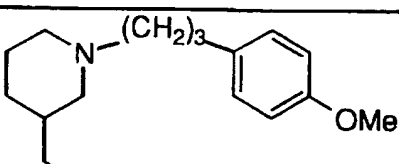
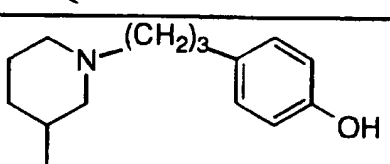
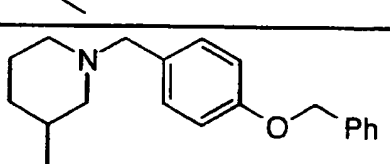
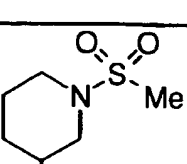
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4B		
4C		
4D		
4E		
4F		
4G		
4H		
4I		
4J		
4K		

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4L		
4M		
4N		
4O		H
4P		H
4Q		
4R		
4S		

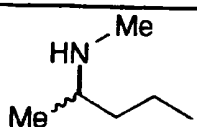
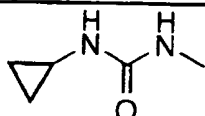
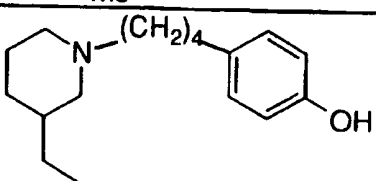
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4T		H
4U		H
4V		H
4W		H
4X		H
4X		H
4Z		H
4AA		H

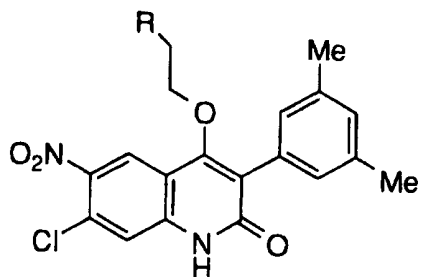
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4BB		H
4CC		H
4DD		H
4EE		H
4FF		
4GG		NO ₂
4HH		
4II		NO ₂
4JJ		NO ₂

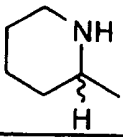
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4KK		
4LL		H

6. The compound of Claim 1 of the structural formula



wherein R is as indicated in the table below:

Example #	R
5A	
5B	